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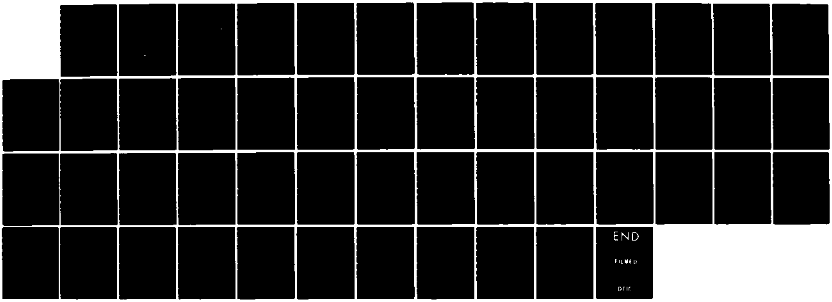

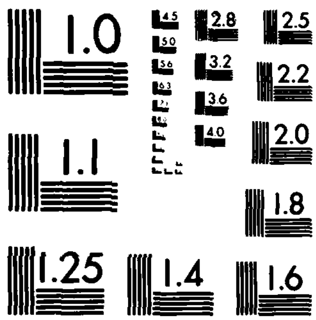
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The Effect of the Choice of Response Matrix on Unfolded Bonner Sphere Spectra

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The effect of the choice of the response matrix on neutron spectra unfolded from Bonner sphere data was studied. In particular, the variation of integral parameters calculated from the unfolded spectra was determined for six matrices. It was determined that, depending on the choice of matrix, the calculated neutron fluence varies by approximately ±15%, the average neutron energy by ±40%, the dose by ±30%, the dose equivalent by up to a factor of 4, and the quality factor by ±35%. For personnel monitoring devices, the calculated response varied by up to a factor of 4 for the Navy albedo badge, a factor of 7 for a cadmium-covered albedo badge, a factor of 6 for a CR-39 dosimeter, and more than two orders of magnitude for NTA type emulsion film. Two of the response matrices gave results in good agreement with other calculated and experimental data.

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THE EFFECT OF THE CHOICE OF RESPONSE MATRIX ON UNFOLDED BONNER SPHERE SPECTRA

INTRODUCTION

In 1960, Bramblett et al [1] suggested that neutron spectra could be determined by using a thermal neutron detector in the center of several moderating spheres of various sizes. They used a small, cylindrical, 4 mm high x 4 mm dia., europium-activated lithium iodide scintillation crystal as the thermal neutron detector in the centers of polyethylene spheres having diameters of 2, 3, 5, 8, and 12 inches. Thermal neutrons arriving at the center of the moderator interact in the scintillator, primarily by the $^{6}Li(n,\alpha)^{3}H$ reaction, producing a 4.79 MeV α particle which is stopped in the crystal. The scintillator is coupled to a photomultiplier and the output is processed to give a measure of the thermal neutron fluence at the center of the moderator. Such spheres are usually called "Bonner spheres" after the senior author of the original paper.

Bonner spheres can serve as a spectrometer because the combined effect of moderation and absorption of the incident neutron spectrum causes the number of thermal neutrons arriving at the centers of the spheres to vary with energy in different ways for the different size moderators. The response of a set of spheres may be written

$$A_j = \int_{E_{min}}^{E_{max}} \sigma_j(E)\Phi(E)dE \qquad j = 1,2,\cdots M \qquad (1)$$

where

A_j is the counting rate of the jth detector,

$\sigma_j(E)$ is the response function of the jth detector as a function of energy

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$\Phi(E)$ is the neutron fluence as a function of energy, and

M is the total number of detectors.

Equation (1) is known formally as a Fredholm integral equation of the first kind. Such equations can only be solved if $\sigma_j(E)$ is an analytical function, which is not the case for Bonner spheres. In practice, Eq. (1) is replaced by a set of linear equations by dividing the energy region into several regions having constant detector responses and fluences. Equation (1) becomes

$$A_j = \sum_{k=1}^{N} \sigma_{jk}\Phi(k) \qquad j = 1,2,\cdots M \qquad (2)$$

where

σ_{jk} is the response of the jth detector to neutrons in the kth energy interval, and

N is the total number of energy intervals.

The set of detector responses, σ_{jk}, called the response matrix, has not been measured with sufficient accuracy because of difficulties in obtaining and characterizing suitable neutron calibration fields. Hence, calculated response matrices are usually employed. Several such matrices have been published, with three appearing in the past few years.

The purpose of our study was to determine how the choice of response matrix affects the neutron spectrum obtained from Bonner sphere data. In particular, we were interested in how the choice of matrix affects integral parameters which are calculated from the unfolded spectrum. These parameters include dose, dose equivalent, total fluence, quality factor, average energy, and the response of personnel monitoring devices and radiation survey instruments. They are calculated using the equation

$$P = \sum_{k=1}^{N} C_k\Phi(k) \qquad (3)$$

where

P is the parameter of interest,

$\Phi(k)$ is the neutron fluence in the kth energy interval, and

C_k is the conversion factor per neutron in the kth energy interval.

THE RESPONSE MATRICES USED FOR THIS STUDY

When Bramblett et al [1] published the original work on the Bonner sphere spectrometer, they reported the experimentally determined response of the detectors for neutrons having energies between 0.05 and 15.1 MeV. Measurements were also made for thermal neutrons, and the response of the various size moderators was estimated for neutrons having energies between 0.025 eV and 50 keV, since no neutron sources were then available having energies in this region. Using this data, Burrus [2] reported a response matrix having 52 energy bins from thermal to 200 MeV. This matrix is usually referred to as M60 [3].

Using an adjoint transport technique, Hansen and Sandmeier [4] calculated the response of the original set of Bonner spheres. These calculated responses, plus those for moderators having diameters of 10, 16, 18, and 20 inches, were reported by McGuire [5]. A 52 energy-bin version of these calculations was reported by O'Brien et al [6]. This 52 bin version is usually referred to as M65 [3].

In 1973, Sanna [7] calculated a 31 group set of responses extending from thermal energies to 400 MeV using the adjoint method of Hansen and Sandmeier. He adjusted the $^6Li(n,\alpha)$ cross section to ensure that the collision probabilities for the cylindrical LiI detector would be retained in each group when it was represented as a spherical detector. In addition to making calculations for a 4 mm x 4 mm detector, Sanna made calculations for 8 mm x 8 mm and 12.7 mm x 12.7 mm detectors in spheres having diameters of 2, 3, 5, 8, 10, 12, and 18 inches. He also investigated the effect of different polyethylene densities and made calculations for water moderators and for gold foil detectors. For the purposes of this comparison, we call the response matrix for the 4 mm x 4 mm LiI detector in polyethylene spheres, SAN4.

Recently, three new response matrices have been caculcated. Using a Monte Carlo method, response matrices were calculated at the Bhabha Atomic Research Center, Bombay, India [8]. For these studies, a 0.245 cm radius ^{6}LiI scintillator, 100% ^{6}Li enrichment, and a density of 4.061 gm/cm^3, was taken as being equivalent to a 4 mm x 4 mm cylindrical scintillator. In addition, the effect of replacing the LiI scintillator by a BF^3 detector was studied. We will refer to the matrix for the 4 mm x 4 mm detector as BARC.

Based on experimental data and calculations available in the literature, Zamborowski [9] showed that a good fit to this data could be obtained by assuming that the response of Bonner spheres of various sizes was given by the energy response function

$$\sigma_j(E) = \frac{F(E)}{S(E)\, r_j \sqrt{2\pi}}\, e^{-\left[\frac{1}{2S^2(E)} (\ln r_j - M(E))^2\right]} \qquad (4)$$

where

$\sigma_j(E)$ is the response of the jth sphere, having a radius in cm of r, as a function of energy, and

F, M, and S are parameters, independent of sphere size, which are adjusted to give the best fit to the calculated and experimental data.

Values of F, M, and S were tabulated for 157 energies between 0.4 eV and 15 MeV for a 4 mm x 4 mm LiI detector. The response matrix obtained from these tabulated values and Eq. (4) is referred to as LOGNM.

The most recently available matrix is one calculated at the University of Texas at Austin by Hertel and Davidson [10,11]. Using newly evaluated cross sections for lithium, carbon, and hydrogen, the method of Hansen and Sandmeir was used to calculate the response of 4 mm x 4 mm and 12.7 mm x 12.7 mm LiI detectors and for moderators having diameters of 2, 3, 5, 8, 10 12, and 18 inches. Calculations were made for 171 energies between thermal and 17.3 MeV . Calculations were also made for the bare detectors and the

detectors in 2-, 3-, and 5-inch diameter spheres covered with 0.76 cm cadmium. We call the matrix for the 4 mm x 4 mm detector UTA4.

As a convenience for unfolding, all the response matrices were re-binned to the SANNA energy intervals. For M60 and M65 this was done by making a spline fit to the data in reference [3]. The neutrons were assumed to be at the log center of the SANNA energy intervals. For the LOGNM data, the responses were calculated for each of the 157 energies and this data was reduced to the SANNA grid using log interpolation. Log interpolation was also done for the UTA4 data. In reducing the LOGNM and UTA4 data, we assumed that the original energies were at the centers of log energy intervals. Intervals that fell completely within a SANNA interval were converted, weighted by the ratio of their log width, to the SANNA interval log width. Intervals which crossed a SANNA interval end-point were divided using a log scale before conversion to the two SANNA intervals. No numerical data was available for the BARC matrix. Two requests to the authors for such data were unanswered, thus the data for the BARC matrix was taken from the graphs in reference [8]. The re-binned data for all six matrices are given in Tables 1a-1f. For all the matrices, the data from UTA4 is used to calculate the effect of covering the spheres with cadmium.

THE NEUTRON SPECTRA

The neutron spectra and the associated Bonner sphere data used to test the response matrices were all generated at the Naval Research Laboratory (NRL) during the course of establishing the response of the Navy albedo neutron personnel monitoring badge to different neutron spectra. Twenty sets of data were chosen, covering the widest range of neutron energies that we could conveniently generate using Cf-252 and AmBe neutron sources moderated by Lucite, polyethylene, steel, and cadmium in various configurations. This data was taken using a set of Bonner spheres obtained from Ludlum Measurements, Inc., Sweetwater, Texas. The detector was a cylindrical 4 mm x 4 mm LiI crystal. The measured density of the polyethelene was 0.96 g/cm^3. Total counts for each detector were greater than 10^4 giving statistical errors on the order of $\pm 1\%$. A description of the various sources is given in Table 2, while the counts for the 2-, 3-, 5-, 8-, 10-, and 12-inch detectors, expressed as the percent of the total counts, are listed in Table 3. The spectra have been

numbered in order of decreasing average neutron energy. Spectra 1, 4, 10, and 12 have errors considerably greater than $\pm 1\%$ because they were separated into source and room-return components. This separation was done using the method of Eisenhauer et al [12]. Even though the data for these spectra have larger errors because of this process, the separation allows us to compare the experimental data to relatively well known calculated data, especially for Cf-252.

Because of the large size of the moderating configurations, it is not possible to separate the direct and room-return components of these spectra. The effective radius of the experimental room is included as an aid in estimating the room-return component. The room having an effective radius of 3.4 meters measures 7.5 x 4.5 x 3.4 meters. The room having an effective radius of 5.0 meters measures 12.2 x 6.1 x 4.6 meters.

METHOD OF SPECTRUM UNFOLDING

The neutron spectra were unfolded from the Bonner sphere data using the YOGI neutron unfolding code developed at NRL by Johnson and Gorbics [13]. Since data for the bare detector were not available for all matrices, we used only the data for the 2-, 3-, 5-, 8-, 10-, and 12-inch detectors. Only the first 25 energy intervals were used for the spectrum unfolding since data were only available to approximately 15 MeV for some of the matrices. Also, from the sources used, Cf-252 and AmBe, significant numbers of neutrons above this energy were not expected. From physical considerations, it was anticipated that the general shape of the spectra could be described by a three-component spectrum made up of a high-energy Maxwellian peak, an intermediate energy component described by $1/E^x$ (E = neutron energy), and a thermal component. Therefore, we first fit the data using the MAXIET algorithm [14] followed by the iterative perturbation method of YOGI. We did not smooth the spectra to the initial MAXIET spectrum. However, to prevent wild oscillations in the spectra due to errors in the data or response matrices, we stopped the unfolding after 25 iterations, using an 8% perturbation. Further unfolding produced no significant improvement in the fit to the data.

THE CONVERSION FACTORS

The conversion factors used to determine integral parameters from the unfolded spectra are listed in Table 4. The response of the Navy albedo badge

was determined by making the best fit to the experimental data from 80 spectra generated for that purpose. The response of a completely cadmium covered albedo badge, often called a "Hankins" dosimeter, was approximated from the calculation of Allsmiller and Barish [15]. The response of the Cr-39 detector was taken from Benton el at [16] and the response of the NTA film from Oshino [17]. The response of the AN/PDR-70 was supplied by Gordon Riel of the Naval Surface Weapons Center. The conversion from neutron fluence to dose was taken from the tabulation of Sanna [18], while the conversion to dose equivalent was supplied by Charles Eisenhauer of the National Bureau of Standards. This conversion was made using log-log interpolation [19] of the data in ICRP 21 [20].

These conversion factors may not necessarily be the most appropriate ones available, but should be adequate for our comparison of the effect of choice of response matrix.

RESULTS AND DISCUSSION

General Fit to the Detector Data

One measure of the appropriateness of a response matrix is how well the Bonner sphere data can be fit. If there are inconsistencies in the response matrix, it is possible to have data which cannot be fit to a reasonable degree of accuracy with any spectrum. If our assumption that these spectra can be fit using a Maxwellian, a $1/E^x$, and a thermal component is correct, then the fit obtained with the various matrices using only these componenets is an indication of their consistency. The root mean square of the fit to the data (% average error) is listed in Table 5 for each spectrum unfolded using each matrix and the MAXIET algorithm. Note that a good fit is obtained, especially with UTA4, SAN4, and LOGNM. There appear to be inconsistencies in M60, M65, and, especially, BARC. After 25 iterations using YOGI, there is considerable improvement to the fit data, the average average error being reduced to less than 0.7% for SAN4 and UTA4. This data is shown in Table 6. In order to illustrate the general characteristics of the fits obtained with each matrix, we have listed the percentage difference between the calculated response of each detector and measured response in Tables 7a-7f. A plus sign indicates that the measured response is lower than the calculated response; but, when considering the matrices, a positive difference indicates that the

calculated response of the matrix is too high. From these tables we can draw the following conclusions:

a. For M60, the responses of the 8" and 12" detectors are too low, or the 10" response is too high.

b. For M65, the responses of the 3" and 10" detectors are too high.

c. For SAN4, the responses of the 2", 5", and 12" detectors are slightly low.

d. For LOGNM, the responses of the 3", 8", and 10" detectors are slightly low, or the other three are too high.

e. For BARC, the responses of the 2", 5", and 10" are too low. Note, particularly, the large discrepancy between the 8", 10", and 12" detectors.

f. For UTA4, the responses of the 2", 5", and 12" detectors are slightly low.

These conclusions suggest that better fits to the data, giving more reasonably shaped spectra, could be obtained if the responses of selected detectors were raised or lowered based on the data in Tables 7a-7f. We did not attempt to do this for this particular study, however.

Agreement with Calculated Spectra

Spectra 4 and 12 were chosen for comparison with the calculations of Grundl and Eisenhauer [21] and Eisenhauer et al [12]. In Table 8 we list the calculated counts for each matrix obtained using the calculated Cf-252 spectrum with the magnitude of the spectrum adjusted to minimize the percent difference between the calculated counts and the experimental counts. Note the remarkable agreement, especially for SAN4 and UTA4. The differences indicate that M60, M65, LOGNM, and UTA4 will give spectra having lower energies than the calculated spectra. There is no discernable trend in the BARC data. In order to compare the experimental spectra with the calculated spectrum, spectra were unfolded using each matrix with the calculated spectrum as a starting spectrum for YOGI. The unfolded spectra were smoothed to the calculated spectrum using a moderate amount of smoothing in YOGI. The unfolded and calculated spectra are shown in Fig. 1. As expected from the data, the SAN4 matrix gives the best fit. It might be argued that the source encapsulation would broaden the spectrum somewhat, in which case, the UTA4 matrix gives the

best fit. The others show a considerable deficiency of high energy neutrons.

The No. 12 spectrum is similarly compared with the calculated room-return spectrum of Eisenhauer [12]. A thermal component was calculated using the equation [22]

$$nv = 1.25\ Q/S \tag{5}$$

where

nv is the thermal neutron fluence rate per cm^3

Q is the Cf-252 emission rate in neutrons per second, and

S is the surface of the calibration room in cm^3.

This component was then combined with the Eisenhauer calculation in order to make a comparison with the experimental data. Note in Table 9 that the calculated counts from this spectrum also indicate that the unfolded spectra will have lower energies when using the M60, M65, LOGNM, and UTA4 response matrices. Again, SAN4 and UTA4 give good agreement with the data, far better than the error of about $\pm 10\%$ estimated for this data.

Using each matrix, spectra were unfolded with the calculated spectrum as a starting spectrum, and smoothed to the starting spectrum. Fits were terminated when the average error dropped below $\pm 1\%$, or after 50 iterations. The spectra obtained with SAN4 and UTA4 are shown in Fig. 2a. The fit terminated after 1 iteration for SAN4 and after 3 iterations for UTA4. As expected, UTA4 gives a slightly softer spectrum. The spectrum obtained with M60, M65, and LOGNM are shown in Fig. 2b. Note the oscillations in the M60 and M65 spectra. These are caused by errors in the response matrices or in the detector data. LOGNM gives a reasonable fit to the data; $\pm 1\%$ error was reached after 20 iterations. However, the spectrum is considerably lower in energy than the calculation. The data for the BARC matrix is shown in Fig. 2c. BARC, M60, and M65 did not fit the data within $\pm 1\%$ after 50 iterations. The error was approximately $\pm 2\%$ for each matrix. Using no smoothing, further unfolding produced oscillations of 10^7 in the spectra without significant improvement in the fit to the data.

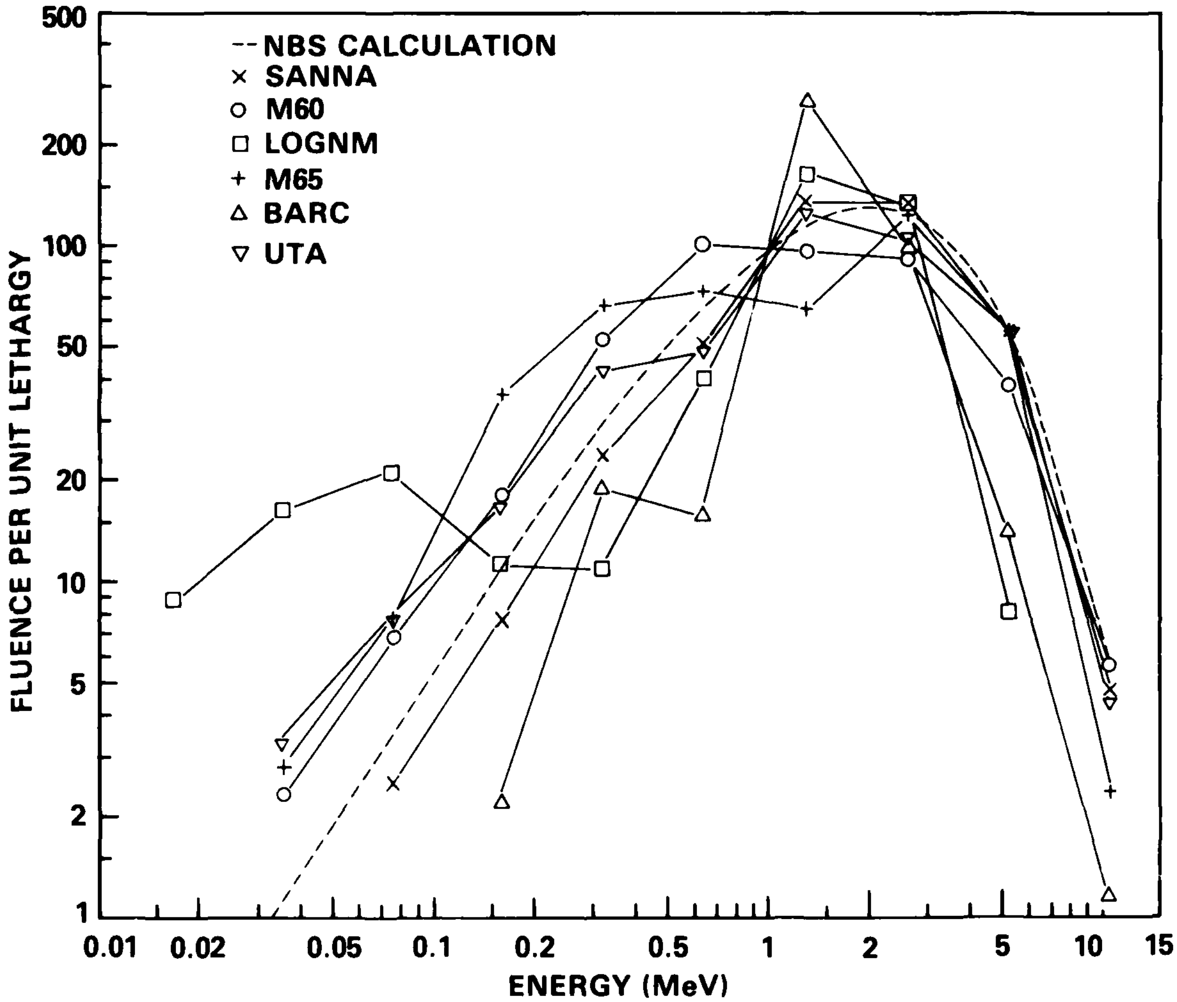

Fig. 1 Cf-252 neutron spectra obtained using each of the the response matrices in the YOGI unfolding code. The spectra were unfolded using the NBS calculation as the starting spectrum for YOGI.

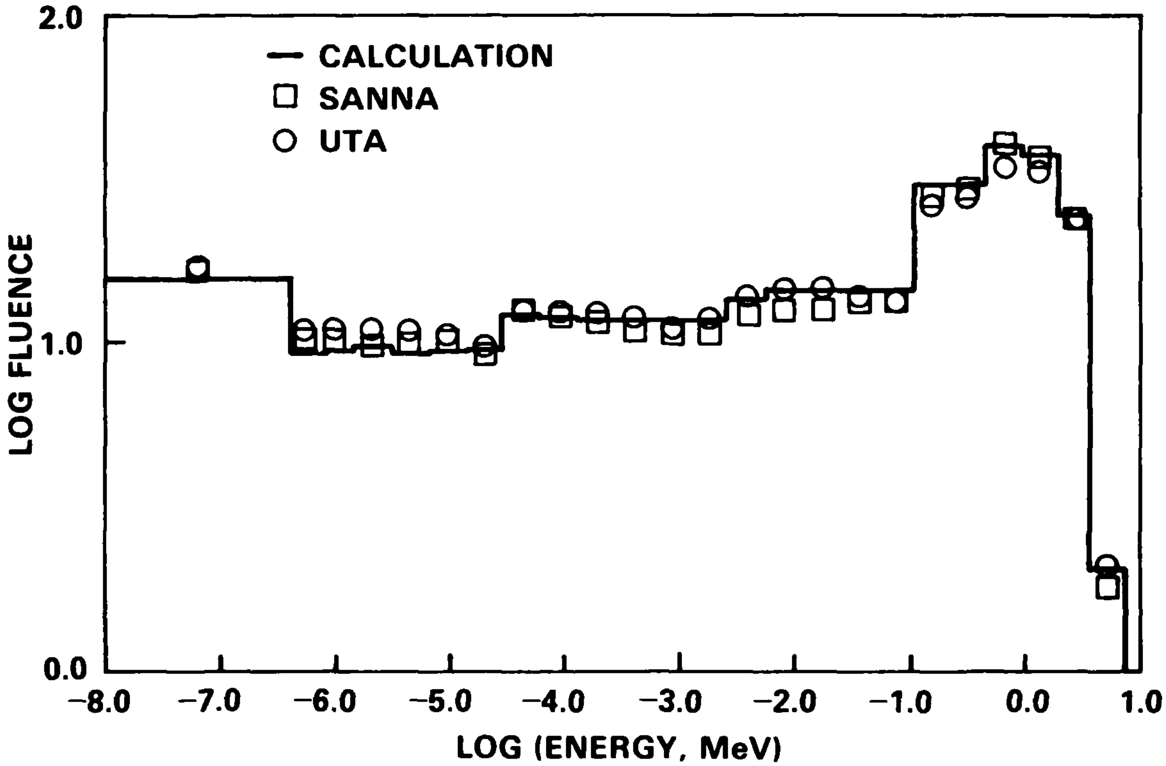

Fig. 2a Cf-252 room-return spectrum obtained using the SAN4 and UTA4 response matrices. The calculated spectrum was used as the starting spectrum for YOGI and the unfolded spectra were smoothed to the calculated spectrum.

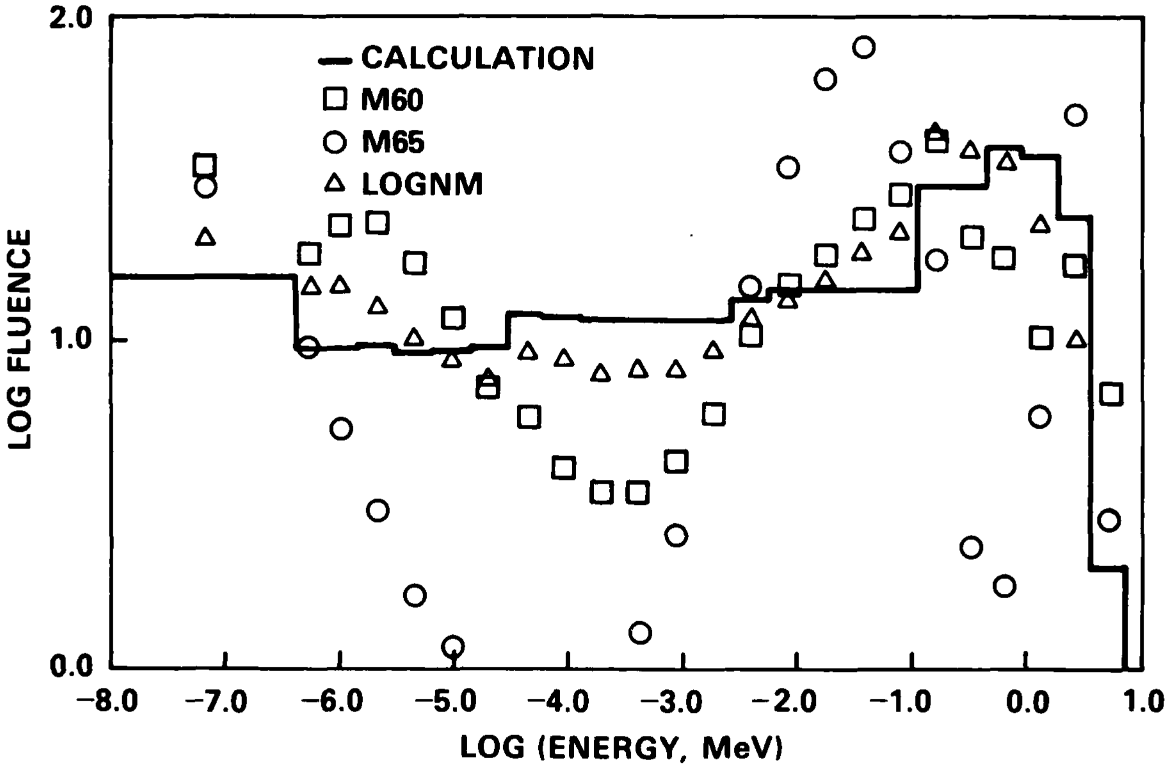

Fig. 2b Cf-252 room-return spectra obtained using the M60, M65, and LOGNM response matrices. The calculated spectrum was used as the starting spectrum for YOGI and the unfolded spectra were smoothed to the calculated spectrum.

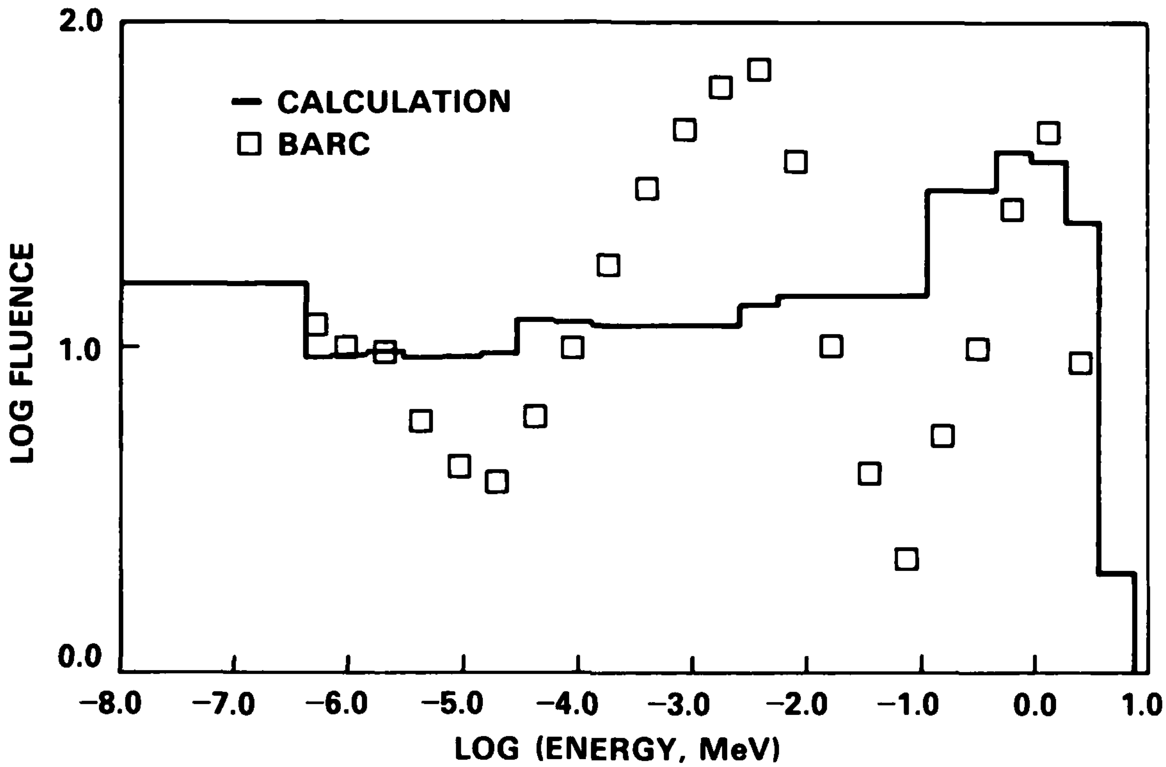

Fig. 2c Cf-252 room-return spectra obtained using the BARC response matrix. The calculated spectrum was used as the starting spectrum for YOGI and the unfolded spectrum was smoothed to the calculated spectrum.

Variation of Integral Parameters

Integral parameters were calculated for each spectrum unfolded with each matrix using Eq. (3) and the conversion factors listed in Table 4. These data are presented in Tables 10a-10j. For each parameter, the average value obtained with all the matrices is given along with the ratio of the response obtained with each matrix relative to the average response.

The fluence data is shown in Table 10a. This data has been normalized using spectrum No. 4, the Cf-252 source with the room-return component removed. This simulates how a Bonner sphere system might typically be calibrated. Generally, the fluence does not vary more than ±15% with choice of matrix. The exception is that M60 tends to significantly overestimate the fluence for spectra having energies less than the bare Cf-252.

The data for average energy is given in Table 10b. There is reasonable agreement for average energies above approximately 1 MeV. SAN4 and UTA4 give exceptionally good agreement with the average energies usually given for Cf-252 (spectrum 4) and AmBe (spectrum 1) of approximately 2.2 and 4.5 MeV. Below this energy, there are significant variations with SAN4 and UTA4 giving 40-70% over-response and LOGNM, and especially BARC, giving a large under-response. The difference between the average energy obtained with SAN4 and BARC is more than a factor of 10 at the lowest energies. Spectra 13 through 20 were all generated with Cf-252 or AmBe in the center of a 60 cm dia. steel sphere. Ing and Cross [23,24] have calculated the spectrum for fission neutrons in the center of such a sphere. The calculated spectrum gives the same detector counts, within ±2%, as a Maxwellian energy distribution having a temperature of 0.30 MeV. Hence, we would expect the Maxwellian component of spectrum No. 13 to have a temperature of approximately 0.3 MeV. The best fit to the data for SAN4, M60, M65, LOGNM, BARC, and UTA4 for spectrum No. 13 are 0.29, 0.21, 0.27, 0.14, 0.15, and 0.28 MeV, respectively. Adding Lucite tends to shift the Maxwellian temperature upward [24] and this trend is observed. We obtain a temperature of approximately 0.45 MeV for spectra 19 and 20 with SAN4 and UTA4, with corresponding lower values for the other matrices.

Considering the variation in average energy, it was expected that there would be considerable variations in dose, dose equivalent, and quality

factor with a strong correlation between the four parameters. This is borne out in Tables 10c, 10d, and 10e where the responses are given respectively for the dose, dose equivalent, and quality factor. There are differences up to a factor of 2 for dose, a factor of 4 for dose equivalent, and a factor of 2 for quality factor, with SAN4 giving the highest values and BARC the lowest.

The calculated response per Rem of 4 personnel dosimeters and a neutron Remmeter are given in Tables 10f-10j. For these calculations, the response of all devices was normalized to the response obtained from the calculated Cf-252 spectrum [21]. The responses of two albedo dosimeters are given in Tables 10f and 10g. The response of the Navy TLD badge, which consists of a ^{6}LiF-^{7}LiF thermoluminescence dosimeter pair behind a 0.38 mm cadmium filter, is given in Table 10f. We see significant variations for the lower energy spectra, with BARC giving significantly higher readings than the average, and SAN4 and UTA4 giving significantly lower readings. Since the conversion factors for this table were obtained using experimental data and the SAN4 matrix, the actual response of this badge to these spectra can be obtained by multiplying the data in column 2 by the data in column 3. The error on this response is approximately $\pm$10%. Thus, the average calculated response for these spectra varies by about a factor of 37, while the measured variation is about a factor of 20. This indicates that these response matrices generally give spectra that are too low in energy, especially for spectra having low average energies. The data for a completely cadmium covered albedo dosimeter is given in Table 10g. This data is very similar to that in Table 10F, however, there is more variation of the response of this dosimeter with neutron energy than with the Navy albedo badge.

The response per Rem of 2 personnel dosimeters which have lower energy cut-offs is given in Tables 10h and 10i. In Table 10h we list the response of a Cr-39 detector which has a lower energy cut-off of approximately 150 keV. There are variations of more than a factor of 6, depending on the choice of matrix. The average response of this dosimeter varies by about a factor of 3.3 over this energy range of spectra, with BARC showing the greatest variation, approximately a factor of 9, and M65 the least, a factor of approximately 2. Our experimental data [25] gives a factor of 3, in good agreement with SAN4 and UTA4. The response per Rem of NTA type film is given in Table

10i. Since NTA film has a lower energy cut-off of approximately 0.5 MeV, we might expect wide variations depending on where the matrix tends to put the energy peak of the lower energy spectra. This is indeed the case; for the lowest energy spectra, there is more than 3 orders of magnitude difference between BARC and the other matrices.

Finally, in Table 10j, we list the response of the AN/PDR-70, an Anderson-Braum type Remmeter. The predicted response of this instrument is within ±20% independent of the choice of matrix.

CONCLUSIONS

The choice of the response matrix used to unfold neutron spectra from Bonner sphere data has a significant effect on the spectra obtained and on the integral parameters calculated from the spectra. Our study indicates that only SAN4 and UTA4 consistently give reasonably shaped spectra that fit the sphere data within experimental error, and agree well with other calculated and experimental data. This study indicates the need for further calculations and experimental verification of the Bonner sphere response matrix in order to optimize the information derived from this type of neutron spectrometer.

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Table 1A

The M60 Response Matrix

MAXIMUM ENERGY (MEV)	DETECTORS											
	0"	0"C	2"	2"C	3"	3"C	5"	5"C	8"	10"	12"	18"
4.140E-07	3.069E+00	5.077E-05	5.026E+00	4.234E-05	4.816E+00	3.996E-05	3.143E+00	2.606E-05	1.086E+00	5.516E-01	2.463E-01	0.000E+00
6.826E-07	2.806E+00	1.731E+00	5.130E+00	2.804E+00	5.220E+00	2.826E+00	3.537E+00	1.888E+00	1.283E+00	6.474E-01	2.592E-01	0.000E+00
1.445E-06	2.459E+00	2.279E+00	5.150E+00	4.636E+00	5.517E+00	4.953E+00	3.850E+00	3.446E+00	1.412E+00	7.156E-01	2.713E-01	0.000E+00
3.059E-06	2.077E+00	2.058E+00	5.120E+00	5.022E+00	5.843E+00	5.720E+00	4.188E+00	4.095E+00	1.559E+00	7.888E-01	2.876E-01	0.000E+00
6.476E-06	1.686E+00	1.684E+00	4.993E+00	4.954E+00	6.168E+00	6.108E+00	4.578E+00	4.528E+00	1.705E+00	8.557E-01	3.039E-01	0.000E+00
1.371E-05	1.245E+00	1.245E+00	4.696E+00	4.671E+00	6.494E+00	6.447E+00	4.935E+00	4.893E+00	1.852E+00	9.309E-01	3.202E-01	0.000E+00
2.902E-05	9.144E-01	9.026E-01	4.351E+00	4.252E+00	6.820E+00	6.643E+00	5.303E+00	5.153E+00	1.998E+00	1.003E+00	3.365E-01	0.000E+00
6.144E-05	5.121E-01	5.030E-01	4.015E+00	3.898E+00	7.132E+00	6.893E+00	5.661E+00	5.453E+00	2.145E+00	1.071E+00	3.528E-01	0.000E+00
1.301E-04	7.591E-02	7.135E-02	3.726E+00	3.375E+00	7.388E+00	6.652E+00	6.019E+00	5.395E+00	2.292E+00	1.146E+00	3.687E-01	0.000E+00
2.754E-04	0.000E+00	0.000E+00	3.454E+00	3.371E+00	7.565E+00	7.349E+00	6.394E+00	6.188E+00	2.438E+00	1.217E+00	4.017E-01	0.000E+00
5.929E-04	0.000E+00	0.000E+00	3.190E+00	3.097E+00	7.596E+00	7.319E+00	6.808E+00	6.533E+00	2.587E+00	1.288E+00	4.219E-01	0.000E+00
1.234E-03	0.000E+00	0.000E+00	2.932E+00	2.898E+00	7.498E+00	7.352E+00	7.236E+00	7.059E+00	2.732E+00	1.360E+00	4.464E-01	0.000E+00
2.613E-03	0.000E+00	0.000E+00	2.662E+00	2.670E+00	7.318E+00	7.282E+00	7.691E+00	7.617E+00	2.887E+00	1.430E+00	4.680E-01	0.000E+00
5.531E-03	0.000E+00	0.000E+00	2.402E+00	2.413E+00	7.072E+00	7.039E+00	8.154E+00	8.076E+00	3.097E+00	1.503E+00	4.905E-01	0.000E+00
1.171E-02	0.000E+00	0.000E+00	2.134E+00	2.149E+00	6.767E+00	6.742E+00	8.619E+00	8.538E+00	3.351E+00	1.639E+00	5.125E-01	0.000E+00
2.479E-02	0.000E+00	0.000E+00	1.871E+00	1.889E+00	6.409E+00	6.396E+00	9.086E+00	9.010E+00	3.690E+00	1.817E+00	5.627E-01	0.000E+00
5.247E-02	0.000E+00	0.000E+00	1.610E+00	1.630E+00	5.970E+00	5.966E+00	9.551E+00	9.478E+00	4.128E+00	2.068E+00	6.741E-01	0.000E+00
1.111E-01	0.000E+00	0.000E+00	1.344E+00	1.366E+00	5.454E+00	5.462E+00	1.001E+01	9.941E+00	4.807E+00	2.429E+00	8.533E-01	0.000E+00
2.237E-01	0.000E+00	0.000E+00	1.091E+00	1.113E+00	4.848E+00	4.869E+00	1.045E+01	1.039E+01	5.748E+00	3.062E+00	1.137E+00	0.000E+00
4.508E-01	0.000E+00	0.000E+00	8.399E-01	8.612E-01	4.046E+00	4.079E+00	1.075E+01	1.072E+01	7.320E+00	4.225E+00	1.699E+00	0.000E+00
9.072E-01	0.000E+00	0.000E+00	6.035E-01	6.235E-01	3.055E+00	3.094E+00	1.048E+01	1.047E+01	1.021E+01	6.644E+00	3.366E+00	0.000E+00
1.872E+00	0.000E+00	0.000E+00	3.441E-01	3.606E-01	2.027E+00	2.071E+00	8.416E+00	8.438E+00	1.131E+01	9.416E+00	5.918E+00	0.000E+00
3.679E+00	0.000E+00	0.000E+00	1.372E-01	1.476E-01	1.083E+00	1.124E+00	5.776E+00	5.832E+00	1.060E+01	1.054E+01	8.227E+00	0.000E+00
7.408E+00	0.000E+00	0.000E+00	7.281E-02	8.077E-02	5.175E-01	5.489E-01	4.058E+00	4.140E+00	7.524E+00	8.612E+00	9.337E+00	0.000E+00
1.492E+01	0.000E+00	0.000E+00	5.403E-02	7.324E-02	2.952E-01	3.473E-01	1.885E+00	1.993E+00	4.766E+00	5.340E+00	5.874E+00	0.000E+00
2.581E+01	0.000E+00	0.000E+00	1.787E-02	2.422E-02	1.352E-01	1.591E-01	1.095E+00	1.158E+00	2.489E+00	3.824E+00	4.728E+00	0.000E+00
4.465E+01	0.000E+00	0.000E+00	1.679E-03	2.276E-03	6.061E-02	7.130E-02	4.831E-01	5.107E-01	1.745E+00	2.959E+00	4.133E+00	0.000E+00
7.725E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.156E-02	2.536E-02	2.093E-01	2.213E-01	1.143E+00	2.555E+00	3.546E+00	0.000E+00
1.336E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.853E-03	1.041E-02	1.241E-01	1.312E-01	2.050E-01	1.627E-01	2.126E+00	0.000E+00
2.312E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 1B

The M65 Response Matrix

MAXIMUM ENERGY (MEV)	DETECTORS											
	0"	0"C	2"	2"C	3"	3"C	5"	5"C	8"	10"	12"	18"
4.140E-07	1.036E+00	1.714E-05	2.127E+00	1.792E-05	1.953E+00	1.620E-05	1.079E+00	8.948E-06	3.105E-01	1.433E-01	4.632E-02	0.000E+00
6.826E-07	9.444E-01	5.825E-01	2.521E+00	1.378E+00	2.498E+00	1.352E+00	1.437E+00	7.671E-01	4.172E-01	1.965E-01	6.755E-02	0.000E+00
1.445E-06	8.293E-01	7.686E-01	2.558E+00	2.303E+00	2.717E+00	2.439E+00	1.625E+00	1.454E+00	4.863E-01	2.315E-01	7.091E-02	0.000E+00
3.059E-06	6.990E-01	6.926E-01	2.496E+00	2.448E+00	2.844E+00	2.784E+00	1.796E+00	1.756E+00	5.352E-01	2.559E-01	7.906E-02	0.000E+00
6.476E-06	5.687E-01	5.680E-01	2.335E+00	2.317E+00	2.875E+00	2.847E+00	1.929E+00	1.908E+00	5.817E-01	2.739E-01	8.909E-02	0.000E+00
1.371E-05	4.184E-01	4.183E-01	2.117E+00	2.106E+00	2.880E+00	2.859E+00	2.031E+00	2.014E+00	6.205E-01	2.902E-01	1.001E-01	0.000E+00
2.902E-05	3.081E-01	3.041E-01	1.926E+00	1.882E+00	2.819E+00	2.746E+00	2.130E+00	2.070E+00	6.695E-01	3.059E-01	1.072E-01	0.000E+00
6.144E-05	1.732E-01	1.701E-01	1.724E+00	1.674E+00	2.721E+00	2.630E+00	2.214E+00	2.133E+00	7.159E-01	3.333E-01	1.100E-01	0.000E+00
1.301E-04	2.523E-02	2.371E-02	1.539E+00	1.394E+00	2.616E+00	2.356E+00	2.287E+00	2.050E+00	7.572E-01	3.488E-01	1.193E-01	0.000E+00
2.754E-04	0.000E+00	0.000E+00	1.372E+00	1.339E+00	2.492E+00	2.421E+00	2.329E+00	2.254E+00	8.079E-01	3.753E-01	1.261E-01	0.000E+00
5.829E-04	0.000E+00	0.000E+00	1.181E+00	1.146E+00	2.337E+00	2.252E+00	2.360E+00	2.265E+00	8.319E-01	3.906E-01	1.300E-01	0.000E+00
1.234E-03	0.000E+00	0.000E+00	1.028E+00	1.016E+00	2.200E+00	2.157E+00	2.376E+00	2.318E+00	8.641E-01	3.895E-01	1.293E-01	0.000E+00
2.613E-03	0.000E+00	0.000E+00	9.064E-01	9.092E-01	2.084E+00	2.074E+00	2.398E+00	2.375E+00	9.164E-01	4.113E-01	1.442E-01	0.000E+00
5.531E-03	0.000E+00	0.000E+00	7.859E-01	7.896E-01	1.916E+00	1.907E+00	2.410E+00	2.387E+00	9.610E-01	4.510E-01	1.503E-01	0.000E+00
1.171E-02	0.000E+00	0.000E+00	6.749E-01	6.795E-01	1.803E+00	1.796E+00	2.419E+00	2.396E+00	1.005E+00	4.754E-01	1.674E-01	0.000E+00
2.479E-02	0.000E+00	0.000E+00	5.742E-01	5.798E-01	1.687E+00	1.684E+00	2.451E+00	2.431E+00	1.082E+00	5.162E-01	1.720E-01	0.000E+00
5.247E-02	0.000E+00	0.000E+00	4.741E-01	4.801E-01	1.536E+00	1.535E+00	2.468E+00	2.449E+00	1.175E+00	5.668E-01	1.987E-01	0.000E+00
1.111E-01	0.000E+00	0.000E+00	3.988E-01	4.053E-01	1.412E+00	1.414E+00	2.521E+00	2.504E+00	1.338E+00	7.089E-01	2.407E-01	0.000E+00
2.237E-01	0.000E+00	0.000E+00	3.129E-01	3.193E-01	1.245E+00	1.250E+00	2.596E+00	2.581E+00	1.603E+00	9.384E-01	3.186E-01	0.000E+00
4.508E-01	0.000E+00	0.000E+00	2.069E-01	2.121E-01	1.011E+00	1.019E+00	2.651E+00	2.643E+00	1.959E+00	1.421E+00	4.751E-01	0.000E+00
9.072E-01	0.000E+00	0.000E+00	1.230E-01	1.271E-01	7.615E-01	7.713E-01	2.492E+00	2.490E+00	2.418E+00	1.975E+00	7.904E-01	0.000E+00
1.872E+00	0.000E+00	0.000E+00	6.755E-02	7.079E-02	4.423E-01	4.518E-01	2.140E+00	2.146E+00	2.731E+00	2.400E+00	1.371E+00	0.000E+00
3.679E+00	0.000E+00	0.000E+00	3.567E-02	3.836E-02	2.683E-01	2.785E-01	1.460E+00	1.474E+00	2.599E+00	2.364E+00	1.921E+00	0.000E+00
7.408E+00	0.000E+00	0.000E+00	1.180E-02	1.309E-02	1.469E-01	1.558E-01	8.118E-01	8.281E-01	2.086E+00	2.104E+00	2.043E+00	0.000E+00
1.492E+01	0.000E+00	0.000E+00	8.673E-03	1.176E-02	6.085E-02	7.158E-02	5.088E-01	5.379E-01	1.302E+00	1.567E+00	1.665E+00	0.000E+00
2.581E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.787E-02	3.279E-02	2.606E-01	2.755E-01	8.495E-01	1.128E+00	1.267E+00	0.000E+00
4.465E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.265E-02	1.488E-02	1.494E-01	1.579E-01	5.462E-01	7.731E-01	9.285E-01	0.000E+00
7.725E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.929E-04	6.975E-04	6.402E-02	6.768E-02	2.831E-01	4.187E-01	5.630E-01	0.000E+00
1.336E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.884E-02	4.106E-02	1.402E-01	2.028E-01	2.462E-01	0.000E+00
2.312E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TABLE 1c

THE SAN4 RESPONSE MATRIX

MAXIMUM ENERGY (MEV)	DETECTORS											
	0"	0"C	2"	2"C	3"	3"C	5"	5"C	8"	10"	12"	18"
4.140E-07	1.685E-01	2.788E-06	1.285E-01	1.083E-06	9.752E-02	8.092E-07	4.754E-02	3.942E-07	1.265E-02	4.805E-03	1.733E-03	4.253E-05
6.826E-07	1.133E-01	6.986E-02	2.628E-01	1.437E-01	2.117E-01	1.146E-01	1.026E-01	5.477E-02	2.690E-02	1.016E-02	3.656E-03	9.221E-05
1.445E-06	9.478E-02	8.784E-02	2.893E-01	2.604E-01	2.529E-01	2.270E-01	1.261E-01	1.129E-01	3.300E-02	1.244E-02	4.476E-03	1.151E-04
3.059E-06	7.413E-02	7.345E-02	2.978E-01	2.921E-01	2.844E-01	2.784E-01	1.476E-01	1.443E-01	3.874E-02	1.459E-02	5.251E-03	1.378E-04
6.476E-06	5.632E-02	5.625E-02	2.908E-01	2.885E-01	3.030E-01	3.001E-01	1.653E-01	1.635E-01	4.365E-02	1.644E-02	5.917E-03	1.582E-04
1.371E-05	4.179E-02	4.178E-02	2.750E-01	2.736E-01	3.124E-01	3.101E-01	1.802E-01	1.787E-01	4.807E-02	1.811E-02	6.519E-03	1.775E-04
2.902E-05	3.029E-02	2.989E-02	2.545E-01	2.487E-01	3.149E-01	3.067E-01	1.931E-01	1.876E-01	5.220E-02	1.967E-02	7.085E-03	1.963E-04
6.144E-05	2.159E-02	2.121E-02	2.321E-01	2.253E-01	3.122E-01	3.017E-01	2.042E-01	1.967E-01	5.615E-02	2.118E-02	7.631E-03	2.150E-04
1.301E-04	1.524E-02	1.432E-02	2.093E-01	1.896E-01	3.056E-01	2.752E-01	2.138E-01	1.916E-01	6.000E-02	2.266E-02	8.170E-03	2.340E-04
2.754E-04	1.081E-02	1.064E-02	1.872E-01	1.827E-01	2.963E-01	2.878E-01	2.221E-01	2.150E-01	6.382E-02	2.414E-02	8.711E-03	2.536E-04
5.929E-04	7.645E-03	7.553E-03	1.663E-01	1.614E-01	2.849E-01	2.745E-01	2.292E-01	2.200E-01	6.763E-02	2.565E-02	9.263E-03	2.739E-04
1.234E-03	5.273E-03	5.244E-03	1.471E-01	1.454E-01	2.722E-01	2.669E-01	2.350E-01	2.292E-01	7.145E-02	2.719E-02	9.828E-03	2.950E-04
2.613E-03	3.658E-03	3.643E-03	1.295E-01	1.299E-01	2.586E-01	2.573E-01	2.399E-01	2.376E-01	7.539E-02	2.881E-02	1.042E-02	3.176E-04
5.531E-03	2.575E-03	2.563E-03	1.136E-01	1.141E-01	2.448E-01	2.437E-01	2.443E-01	2.420E-01	7.961E-02	3.058E-02	1.108E-02	3.427E-04
1.171E-02	1.935E-03	1.929E-03	9.916E-02	9.984E-02	2.309E-01	2.300E-01	2.487E-01	2.464E-01	8.448E-02	3.267E-02	1.186E-02	3.724E-04
2.479E-02	1.450E-03	1.448E-03	8.595E-02	8.679E-02	2.174E-01	2.170E-01	2.544E-01	2.523E-01	9.074E-02	3.541E-02	1.289E-02	4.116E-04
5.247E-02	1.102E-03	1.101E-03	7.345E-02	7.438E-02	2.039E-01	2.038E-01	2.629E-01	2.609E-01	9.996E-02	3.956E-02	1.447E-02	4.714E-04
1.111E-01	8.694E-04	8.689E-04	6.089E-02	6.188E-02	1.893E-01	1.896E-01	2.763E-01	2.744E-01	1.154E-01	4.684E-02	1.731E-02	5.812E-04
2.237E-01	1.175E-03	1.172E-03	4.811E-02	4.910E-02	1.712E-01	1.719E-01	2.933E-01	2.916E-01	1.414E-01	6.050E-02	2.297E-02	8.162E-04
4.508E-01	1.854E-03	1.850E-03	3.526E-02	3.615E-02	1.458E-01	1.470E-01	3.061E-01	3.052E-01	1.834E-01	8.727E-02	3.577E-02	1.487E-03
9.072E-01	4.449E-04	4.479E-04	2.252E-02	2.326E-02	1.117E-01	1.131E-01	2.993E-01	2.990E-01	2.400E-01	1.315E-01	6.554E-02	4.236E-03
1.872E+00	2.703E-04	2.731E-04	1.312E-02	1.375E-02	7.833E-02	8.001E-02	2.767E-01	2.774E-01	3.141E-01	2.246E-01	1.371E-01	1.927E-02
3.679E+00	1.790E-04	1.836E-04	6.327E-03	6.804E-03	4.351E-02	4.517E-02	1.942E-01	1.961E-01	2.972E-01	2.593E-01	1.944E-01	5.332E-02
7.408E+00	1.021E-04	1.056E-04	2.811E-03	3.118E-03	2.179E-02	2.311E-02	1.203E-01	1.227E-01	2.423E-01	2.527E-01	2.273E-01	1.109E-01
1.492E+01	5.006E-05	5.449E-05	1.124E-03	1.524E-03	9.562E-03	1.125E-02	6.260E-02	6.618E-02	1.568E-01	1.875E-01	1.934E-01	1.430E-01
2.581E+01	4.595E-05	5.000E-05	5.662E-04	7.675E-04	4.614E-03	5.428E-03	3.009E-02	3.181E-02	7.739E-02	9.516E-02	1.014E-01	8.430E-02
4.465E+01	3.001E-05	3.267E-05	3.362E-04	4.557E-04	2.741E-03	3.225E-03	1.837E-02	1.942E-02	4.967E-02	6.335E-02	7.015E-02	6.626E-02
7.725E+01	1.873E-05	2.039E-05	2.240E-04	3.036E-04	1.849E-03	2.175E-03	1.270E-02	1.343E-02	3.582E-02	4.716E-02	5.407E-02	5.751E-02
1.336E+02	1.219E-05	1.326E-05	1.734E-04	2.350E-04	1.458E-03	1.715E-03	1.022E-02	1.080E-02	2.991E-02	4.050E-02	4.785E-02	5.626E-02
2.312E+02	7.955E-06	8.657E-06	1.423E-04	1.929E-04	1.242E-03	1.461E-03	9.072E-03	9.591E-03	2.784E-02	3.875E-02	4.702E-02	5.975E-02
4.000E+02	4.698E-06	5.113E-06	1.227E-04	1.664E-04	1.099E-03	1.293E-03	8.189E-03	8.658E-03	2.579E-02	3.653E-02	4.510E-02	6.043E-02

Table 1D

The LOGNM Response Matrix

MAXIMUM ENERGY (MEV)	DETECTORS 0"	0"C	2"	2"C	3"	3"C	5"	5"C	8"	10"	12"	18"
4.140E-07	0.000E+00	0.000E+00	1.498E-01	1.262E-06	1.231E-01	1.021E-06	6.369E-02	5.281E-07	1.859E-02	8.799E-03	4.461E-03	1.043E-04
6.826E-07	0.000E+00	0.000E+00	2.569E-01	1.404E-01	2.466E-01	1.335E-01	1.355E-01	7.233E-02	4.555E-02	2.265E-02	1.174E-02	2.060E-03
1.445E-06	0.000E+00	0.000E+00	2.748E-01	2.474E-01	2.843E-01	2.552E-01	1.634E-01	1.463E-01	5.451E-02	2.656E-02	1.344E-02	2.178E-03
3.059E-06	0.000E+00	0.000E+00	2.572E-01	2.523E-01	2.929E-01	2.868E-01	1.793E-01	1.753E-01	5.987E-02	2.864E-02	1.414E-02	2.108E-03
6.476E-06	0.000E+00	0.000E+00	2.261E-01	2.243E-01	2.853E-01	2.825E-01	1.879E-01	1.858E-01	6.346E-02	2.996E-02	1.450E-02	2.010E-03
1.371E-05	0.000E+00	0.000E+00	1.900E-01	1.890E-01	2.673E-01	2.653E-01	1.914E-01	1.898E-01	6.620E-02	3.104E-02	1.482E-02	1.936E-03
2.902E-05	0.000E+00	0.000E+00	1.583E-01	1.547E-01	2.484E-01	2.419E-01	1.935E-01	1.880E-01	6.862E-02	3.200E-02	1.507E-02	1.862E-03
6.144E-05	0.000E-00	0.000E+00	1.327E-01	1.288E-01	2.314E-01	2.236E-01	1.953E-01	1.881E-01	7.087E-02	3.283E-02	1.526E-02	1.781E-03
1.301E-04	0.000E+00	0.000E+00	1.120E-01	1.014E-01	2.160E-01	1.945E-01	1.970E-01	1.766E-01	7.310E-02	3.368E-02	1.546E-02	1.713E-03
2.754E-04	0.000E+00	0.000E+00	9.520E-02	9.292E-02	2.020E-01	1.962E-01	1.985E-01	1.921E-01	7.543E-02	3.462E-02	1.573E-02	1.663E-03
5.929E-04	0.000E+00	0.000E+00	8.112E-02	7.875E-02	1.890E-01	1.821E-01	2.003E-01	1.922E-01	7.836E-02	3.597E-02	1.624E-02	1.658E-03
1.234E-03	0.000E+00	0.000E+00	6.991E-02	6.910E-02	1.774E-01	1.739E-01	2.019E-01	1.970E-01	8.137E-02	3.743E-02	1.682E-02	1.671E-03
2.613E-03	0.000E+00	0.000E+00	6.106E-02	6.125E-02	1.673E-01	1.665E-01	2.031E-01	2.012E-01	8.419E-02	3.884E-02	1.741E-02	1.691E-03
5.531E-03	0.000E+00	0.000E+00	5.327E-02	5.352E-02	1.576E-01	1.569E-01	2.044E-01	2.025E-01	8.729E-02	4.041E-02	1.809E-02	1.721E-03
1.171E-02	0.000E+00	0.000E+00	4.582E-02	4.614E-02	1.477E-01	1.472E-01	2.060E-01	2.041E-01	9.092E-02	4.227E-02	1.888E-02	1.758E-03
2.479E-02	0.000E+00	0.000E+00	3.867E-02	3.905E-02	1.371E-01	1.368E-01	2.074E-01	2.057E-01	9.493E-02	4.433E-02	1.975E-02	1.791E-03
5.247E-02	0.000E+00	0.000E+00	3.173E-02	3.213E-02	1.253E-01	1.252E-01	2.086E-01	2.070E-01	1.000E-01	4.712E-02	2.100E-02	1.866E-03
1.111E-01	0.000E+00	0.000E+00	2.520E-02	2.561E-02	1.130E-01	1.132E-01	2.107E-01	2.092E-01	1.072E-01	5.116E-02	2.287E-02	1.399E-03
2.237E-01	0.000E+00	0.000E+00	1.948E-02	1.988E-02	9.995E-02	1.004E-01	2.148E-01	2.136E-01	1.213E-01	6.024E-02	2.772E-02	2.549E-03
4.508E-01	0.000E+00	0.000E+00	1.415E-02	1.451E-02	8.366E-02	8.434E-02	2.174E-01	2.168E-01	1.480E-01	8.081E-02	4.027E-02	4.464E-03
9.072E-01	0.000E+00	0.000E+00	8.654E-03	8.940E-03	5.959E-02	6.036E-02	2.007E-01	2.005E-01	1.875E-01	1.226E-01	7.195E-02	1.216E-02
1.872E+00	0.000E+00	0.000E+00	5.243E-03	5.495E-03	4.048E-02	4.135E-02	1.740E-01	1.745E-01	2.234E-01	1.751E-01	1.208E-01	3.058E-02
3.679E+00	0.000E+00	0.000E+00	2.414E-03	2.596E-03	2.138E-02	2.219E-02	1.189E-01	1.200E-01	2.090E-01	1.944E-01	1.557E-01	5.629E-02
7.408E+00	0.000E+00	0.000E+00	1.203E-03	1.335E-03	1.116E-02	1.184E-02	7.402E-02	7.551E-02	1.723E-01	1.912E-01	1.808E-01	1.023E-01
1.492E+01	0.000E+00	0.000E+00	8.719E-04	1.182E-03	6.675E-03	7.853E-03	4.073E-02	4.306E-02	1.006E-01	1.196E-01	1.220E-01	8.648E-02
2.581E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.465E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
7.725E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1.336E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E 00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2.312E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 1E

The BARC Response Matrix

MAXIMUM ENERGY (MEV)	DETECTORS 0"	0"C	2"	2"C	3"	3"C	5"	5"C	8"	10"	12"	18"
4.140E-07	0.000E+00	0.000E+00	2.139E-01	1.802E-06	1.581E-01	1.312E-06	9.620E-02	7.977E-07	3.140E-02	4.300E-03	8.900E-03	0.000E+00
6.826E-07	0.000E+00	0.000E+00	2.279E-01	1.246E-01	2.001E-01	1.083E-01	1.479E-01	7.895E-02	4.470E-02	1.790E-02	9.300E-03	0.000E+00
1.445E-06	0.000E+00	0.000E+00	2.263E-01	2.037E-01	2.136E-01	1.918E-01	1.598E-01	1.430E-01	4.690E-02	2.150E-02	1.060E-02	0.000E+00
3.059E-06	0.000E+00	0.000E+00	2.211E-01	2.169E-01	2.253E-01	2.206E-01	1.703E-01	1.665E-01	5.150E-02	2.790E-02	1.110E-02	0.000E+00
6.476E-06	0.000E+00	0.000E+00	2.135E-01	2.118E-01	2.349E-01	2.326E-01	1.724E-01	1.705E-01	5.830E-02	3.140E-02	1.210E-02	0.000E+00
1.371E-05	0.000E+00	0.000E+00	2.067E-01	2.056E-01	2.402E-01	2.384E-01	1.807E-01	1.792E-01	6.790E-02	3.570E-02	1.310E-02	0.000E+00
2.902E-05	0.000E+00	0.000E+00	1.962E-01	1.917E-01	2.434E-01	2.371E-01	1.832E-01	1.780E-01	7.380E-02	3.690E-02	1.350E-02	0.000E+00
6.144E-05	0.000E+00	0.000E+00	1.884E-01	1.829E-01	2.405E-01	2.324E-01	1.836E-01	1.769E-01	7.310E-02	3.870E-02	1.430E-02	0.000E+00
1.301E-04	0.000E+00	0.000E+00	1.718E-01	1.556E-01	2.358E-01	2.123E-01	1.875E-01	1.681E-01	7.020E-02	4.150E-02	1.530E-02	0.000E+00
2.754E-04	0.000E+00	0.000E+00	1.606E-01	1.567E-01	2.260E-01	2.195E-01	1.906E-01	1.845E-01	7.100E-02	4.190E-02	1.590E-02	0.000E+00
5.929E-04	0.000E+00	0.000E+00	1.519E-01	1.475E-01	2.179E-01	2.100E-01	1.938E-01	1.860E-01	7.230E-02	4.310E-02	1.710E-02	0.000E+00
1.234E-03	0.000E+00	0.000E+00	1.335E-01	1.319E-01	2.057E-01	2.017E-01	1.973E-01	1.925E-01	7.590E-02	4.420E-02	1.820E-02	0.000E+00
2.613E-03	0.000E+00	0.000E+00	1.189E-01	1.193E-01	1.933E-01	1.924E-01	2.001E-01	1.982E-01	8.180E-02	4.560E-02	1.850E-02	0.000E+00
5.531E-03	0.000E+00	0.000E+00	1.098E-01	1.103E-01	1.862E-01	1.853E-01	2.057E-01	2.037E-01	8.560E-02	4.710E-02	1.950E-02	0.000E+00
1.171E-02	0.000E+00	0.000E+00	8.520E-02	8.579E-02	1.776E-01	1.769E-01	2.084E-01	2.064E-01	9.430E-02	4.990E-02	1.980E-02	0.000E+00
2.479E-02	0.000E+00	0.000E+00	6.730E-02	6.796E-02	1.708E-01	1.705E-01	2.105E-01	2.087E-01	1.115E-01	5.010E-02	2.190E-02	0.000E+00
5.247E-02	0.000E+00	0.000E+00	6.240E-02	6.319E-02	1.611E-01	1.610E-01	2.152E-01	2.136E-01	1.230E-01	5.030E-02	2.450E-02	0.000E+00
1.111E-01	0.000E+00	0.000E+00	5.370E-02	5.457E-02	1.504E-01	1.506E-01	2.196E-01	2.181E-01	1.613E-01	5.490E-02	3.120E-02	0.000E+00
2.237E-01	0.000E+00	0.000E+00	4.360E-02	4.449E-02	1.355E-01	1.361E-01	2.458E-01	2.444E-01	1.879E-01	6.580E-02	4.230E-02	0.000E+00
4.508E-01	0.000E+00	0.000E+00	3.650E-02	3.742E-02	1.229E-01	1.239E-01	2.503E-01	2.496E-01	2.094E-01	8.610E-02	5.750E-02	0.000E+00
9.072E-01	0.000E+00	0.000E+00	2.710E-02	2.800E-02	8.990E-02	9.106E-02	2.329E-01	2.327E-01	2.542E-01	1.128E-01	8.270E-02	0.000E+00
1.872E+00	0.000E+00	0.000E+00	1.190E-02	1.247E-02	5.230E-02	5.342E-02	1.886E-01	1.891E-01	2.738E-01	1.590E-01	1.200E-01	0.000E+00
3.679E+00	0.000E+00	0.000E+00	4.800E-03	5.162E-03	3.260E-02	3.384E-02	1.471E-01	1.485E-01	2.541E-01	1.912E-01	1.839E-01	0.000E+00
7.408E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.310E-02	1.390E-02	8.730E-02	8.906E-02	2.200E-01	1.789E-01	1.875E-01	0.000E+00
1.492E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.070E-02	1.259E-02	1.650E-02	1.744E-02	1.203E-01	1.251E-01	1.168E-01	0.000E+00
2.581E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.465E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
7.725E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1.336E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2.312E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.000E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 1F

The UTA4 Response Matrix

MAXIMUM ENERGY (MEV)	DETECTORS 0"	0"C	2"	2"C	3"	3"C	5"	5"C	8"	10"	12"	18"
4.140E-07	1.484E-01	2.455E-06	1.498E-01	1.262E-06	1.251E-01	1.038E-06	6.524E-02	5.410E-07	1.831E-02	7.187E-03	2.710E-03	1.268E-04
6.826E-07	1.127E-01	6.951E-02	2.261E-01	1.236E-01	2.154E-01	1.166E-01	1.180E-01	6.299E-02	3.305E-02	1.292E-02	4.859E-03	2.262E-04
1.445E-06	9.523E-02	8.826E-02	2.275E-01	2.048E-01	2.317E-01	2.080E-01	1.315E-01	1.177E-01	3.700E-02	1.446E-02	5.434E-03	2.528E-04
3.059E-06	7.483E-02	7.414E-02	2.200E-01	2.158E-01	2.429E-01	2.378E-01	1.448E-01	1.416E-01	4.109E-02	1.606E-02	6.034E-03	2.805E-04
6.476E-06	5.677E-02	5.670E-02	2.065E-01	2.049E-01	2.473E-01	2.449E-01	1.558E-01	1.541E-01	4.475E-02	1.750E-02	6.573E-03	3.054E-04
1.371E-05	4.185E-02	4.184E-02	1.898E-01	1.888E-01	2.467E-01	2.449E-01	1.651E-01	1.637E-01	4.815E-02	1.884E-02	7.078E-03	3.288E-04
2.902E-05	3.019E-02	2.980E-02	1.719E-01	1.680E-01	2.425E-01	2.362E-01	1.730E-01	1.681E-01	5.140E-02	2.014E-02	7.567E-03	3.514E-04
6.144E-05	2.148E-02	2.110E-02	1.540E-01	1.495E-01	2.357E-01	2.278E-01	1.797E-01	1.731E-01	5.456E-02	2.142E-02	8.048E-03	3.737E-04
1.301E-04	1.514E-02	1.423E-02	1.369E-01	1.240E-01	2.270E-01	2.044E-01	1.852E-01	1.660E-01	5.765E-02	2.269E-02	8.528E-03	3.960E-04
2.754E-04	1.057E-02	1.040E-02	1.209E-01	1.180E-01	2.169E-01	2.107E-01	1.897E-01	1.836E-01	6.071E-02	2.397E-02	9.014E-03	4.185E-04
5.929E-04	7.302E-03	7.214E-03	1.060E-01	1.029E-01	2.060E-01	1.985E-01	1.933E-01	1.855E-01	6.381E-02	2.529E-02	9.519E-03	4.420E-04
1.234E-03	5.067E-03	5.039E-03	9.288E-02	9.180E-02	1.948E-01	1.910E-01	1.961E-01	1.913E-01	6.688E-02	2.662E-02	1.003E-02	4.659E-04
2.613E-03	3.515E-03	3.501E-03	8.112E-02	8.137E-02	1.835E-01	1.826E-01	1.982E-01	1.963E-01	7.001E-02	2.803E-02	1.057E-02	4.912E-04
5.531E-03	2.429E-03	2.417E-03	7.050E-02	7.083E-02	1.723E-01	1.715E-01	1.999E-01	1.980E-01	7.341E-02	2.958E-02	1.118E-02	5.194E-04
1.171E-02	1.683E-03	1.678E-03	6.097E-02	6.139E-02	1.613E-01	1.607E-01	2.018E-01	1.999E-01	7.733E-02	3.142E-02	1.190E-02	5.532E-04
2.479E-02	1.177E-03	1.175E-03	5.237E-02	5.288E-02	1.507E-01	1.504E-01	2.044E-01	2.027E-01	8.236E-02	3.381E-02	1.285E-02	5.976E-04
5.247E-02	8.348E-04	8.340E-04	4.429E-02	4.485E-02	1.403E-01	1.402E-01	2.092E-01	2.076E-01	8.985E-02	3.745E-02	1.431E-02	6.662E-04
1.111E-01	6.865E-04	6.861E-04	3.624E-02	3.683E-02	1.290E-01	1.292E-01	2.174E-01	2.159E-01	1.025E-01	4.388E-02	1.695E-02	7.922E-04
2.237E-01	1.276E-03	1.273E-03	2.826E-02	2.884E-02	1.154E-01	1.159E-01	2.279E-01	2.266E-01	1.237E-01	5.591E-02	2.220E-02	1.057E-03
4.508E-01	1.686E-03	1.682E-03	2.055E-02	2.107E-02	9.698E-02	9.777E-02	2.344E-01	2.337E-01	1.573E-01	7.897E-02	3.382E-02	1.770E-03
9.072E-01	3.281E-04	3.303E-04	1.270E-02	1.312E-02	7.293E-02	7.387E-02	2.254E-01	2.252E-01	2.009E-01	1.197E-01	5.998E-02	4.488E-03
1.872E+00	2.554E-04	2.581E-04	6.957E-03	7.291E-03	4.744E-02	4.846E-02	1.908E-01	1.913E-01	2.354E-01	1.741E-01	1.089E-01	1.624E-02
3.679E+00	1.830E-04	1.877E-04	3.406E-03	3.663E-03	2.652E-02	2.753E-02	1.347E-01	1.360E-01	2.227E-01	2.000E-01	1.529E-01	4.345E-02
7.408E+00	9.175E-05	9.492E-05	1.518E-03	1.684E-03	1.318E-02	1.398E-02	8.243E-02	8.409E-02	1.792E-01	1.925E-01	1.773E-01	9.178E-02
1.492E+01	6.260E-05	6.813E-05	6.268E-04	8.496E-04	5.663E-03	6.662E-03	4.124E-02	4.360E-02	1.104E-01	1.356E-01	1.428E-01	1.115E-01
2.581E+01	5.746E-05	6.252E-05	3.157E-04	4.279E-04	2.733E-03	3.214E-03	1.982E-02	2.096E-02	5.449E-02	6.882E-02	7.487E-02	6.573E-02
4.465E+01	3.753E-05	4.085E-05	1.875E-04	2.540E-04	1.623E-03	1.910E-03	1.210E-02	1.279E-02	3.497E-02	4.581E-02	5.180E-02	5.166E-02
7.725E+01	2.342E-05	2.549E-05	1.249E-04	1.693E-04	1.095E-03	1.288E-03	8.367E-03	8.848E-03	2.522E-02	3.411E-02	3.992E-02	4.484E-02
1.336E+02	1.524E-05	1.658E-05	9.670E-05	1.310E-04	8.635E-04	1.016E-03	6.733E-03	7.115E-03	2.106E-02	2.929E-02	3.533E-02	4.387E-02
2.312E+02	9.948E-06	1.082E-05	7.935E-05	1.075E-04	7.356E-04	8.652E-04	5.977E-03	6.319E-03	1.960E-02	2.802E-02	3.472E-02	4.659E-02
4.000E+02	5.875E-06	6.393E-06	6.842E-05	9.276E-05	6.509E-04	7.657E-04	5.395E-03	5.704E-03	1.816E-02	2.642E-02	3.330E-02	4.712E-02

TABLE 2

DESCRIPTIONS OF THE SOURCES AND MODERATORS USED TO PRODUCE THE NEUTRON SPECTRA USED IN THIS STUDY

SPECTRUM NUMBER	NEUTRON SOURCE	SOURCE-DETECTOR DISTANCE (M)	ROOM RADIUS (M)	SOURCE MODERATION
1	Am-Be	1.0	3.4	None - room return removed
2	Am-Be	1.0	3.4	None
3	Am-Be	0.5	3.4	Lucite slab 23cm dia, 15.2 thick between source and detectors
4	Cf-252	1.0	3.4	None - room return removed
5	Cf-252	0.5	3.4	Source in center of 5.1cm dia Polyethylene ball
6	Cf-252	1.0	3.4	None
7	Cf-252	0.5	3.4	Source in center of 25.4cm dia Polyethylene ball
8	Am-Be	5.0	5.0	None
9	Cf-252	0.5	3.4	Source in center of 12.7cm dia Polyethylene ball
10	Am-Be	1.0	3.4	None - room return spectrum
11	Cf-252	1.0	3.4	Source in center of steel cylinder, 23cm dia x 25.4cm high
12	Cf-252	1.0	3.4	None - room return spectrum
13	Cf-252	1.0	3.4	Source in center of 60cm dia steel ball
14	Cf-252	5.0	5.0	Source in center of steel cylinder, 23cm dia x 25.4cm high
15	Cf-252	1.0	3.4	Source in ctr of 60cm dia steel ball with 66cm x 66cm x 1.27cm thick Lucite plate between source and detectors
16	Cf-252	1.0	3.4	Source in ctr of 60cm dia steel ball with 66cm x 66cm x 1.27cm thick Cd covered Lucite plate betw. source and detectors
17	Am-Be	1.0	3.4	Source in ctr of 60cm dia steel ball with 66cm x 66cm x 7.6cm thick Cd covered Lucite plate betw. source and detectors
18	Cf-252	1.0	3.4	Source in ctr of 60cm dia steel ball with 66cm x 66cm x 3.8cm thick Lucite plate between source and detectors
19	Cf-252	1.0	3.4	Source in ctr of 60cm dia steel ball with 66cm x 66cm x 7.6cm thick Lucite plate between source and detectors
20	Cf-252	1.0	3.4	Source in ctr of 60cm dia steel ball with 66cm x 66cm x 7.6cm thick Cd covered Lucite plate betw. source and detectors

TABLE 3

THE DETECTOR COUNTS, EXPRESSED AS THE PERCENT OF THE TOTAL COUNTS, FOR THE VARIOUS NEUTRON SPECTRA

SPECTRUM NUMBER	DETECTOR RESPONSE (% of total) 2"	3"	5"	8"	10"	12"
1	1.04	5.26	18.70	28.01	25.70	21.29
2	4.25	9.07	20.76	25.66	22.26	18.00
3	9.10	13.43	21.64	22.78	18.61	14.44
4	1.37	7.20	24.20	29.13	22.52	15.58
5	4.89	12.39	26.19	25.15	18.76	12.61
6	5.23	11.59	25.83	25.59	18.93	12.71
7	15.39	19.34	23.79	18.88	13.55	9.05
8	15.94	23.00	26.09	17.03	10.80	7.12
9	11.91	17.65	25.62	20.87	14.53	9.42
10	16.21	22.09	26.97	17.13	10.87	6.73
11	6.04	14.82	30.26	24.45	15.49	8.94
12	15.91	24.21	28.80	16.64	9.30	5.15
13	8.89	20.22	34.29	20.73	10.76	5.10
14	18.66	27.14	28.87	14.22	7.54	3.57
15	11.45	23.13	33.61	18.28	9.27	4.27
16	14.39	25.38	32.05	16.29	8.27	3.62
17	17.53	26.85	30.99	14.40	6.92	3.31
18	17.15	26.94	30.64	14.80	7.25	3.22
19	22.05	28.93	28.22	12.31	5.85	2.65
20	18.61	28.28	30.17	13.47	6.49	2.98

TABLE 4
THE CONVERSION FACTORS, RESPONSE PER NEUTRON, FOR THE PARAMETERS CALCULATED FROM THE UNFOLDED NEUTRON SPECTRA

MAXIMUM NEUTRON ENERGY (MEV)	NAVY ALBEDO	HANKINS ALBEDO	NEUTRAK CR-39	NTA FILM	AN/PDR-70 REM-METER	DOSE	DOSE EQUIVALENT
4.14E-7	1.006E-7	3.357E-11	0	0	1.066E-9	5.260E-10	1.151E-9
6.83E-7	"	4.796E-7	0	0	1.293E-9	6.088E-10	1.232E-9
1.45E-6	"	4.796E-7	0	0	1.316E-9	6.175E-10	1.254E-9
3.06E-6	"	5.329E-7	0	0	1.384E-9	6.135E-10	1.244E-9
6.48E-6	"	3.837E-7	0	0	1.429E-9	6.070E-10	1.227E-9
1.37E-5	"	3.597E-7	0	0	1.474E-9	6.008E-10	1.211E-9
2.90E-5	"	3.118E-7	0	0	1.520E-9	5.970E-10	1.195E-9
6.14E-5	"	2.878E-7	0	0	1.558E-9	5.937E-10	1.179E-9
1.30E-4	"	2.398E-7	0	0	1.633E-9	5.892E-10	1.161E-9
2.75E-4	"	2.206E-7	0	0	1.701E-9	5.698E-10	1.123E-9
5.93E-4	"	2.014E-7	0	0	1.747E-9	5.465E-10	1.080E-9
1.23E-3	"	1.439E-7	0	0	1.815E-9	5.251E-10	1.040E-9
2.61E-3	9.937E-8	1.343E-7	0	0	1.860E-9	5.149E-10	1.020E-9
5.53E-3	9.308E-8	1.295E-7	0	0	1.906E-9	5.083E-10	1.008E-9
1.17E-2	8.302E-8	1.199E-7	0	0	1.838E-9	5.039E-10	1.009E-9
2.48E-2	7.547E-8	1.151E-7	0	0	2.654E-9	5.629E-10	1.514E-9
5.25E-2	6.792E-8	1.103E-7	0	0	3.834E-9	6.639E-10	2.687E-9
1.11E-1	6.138E-8	9.592E-8	0	0	6.103E-9	7.847E-10	4.775E-9
2.24E-1	5.535E-8	8.153E-8	4.876E-9	0	8.757E-9	1.038E-9	8.299E-9
4.51E-1	4.730E-8	6.235E-8	7.963E-9	3.557E-9	1.407E-8	1.454E-9	1.416E-8
9.07E-1	4.025E-8	4.796E-8	1.177E-8	1.352E-8	2.613E-8	2.244E-9	2.391E-8
1.87E+0	3.346E-8	3.022E-8	2.157E-8	2.202E-8	3.593E-8	3.406E-9	3.506E-8
3.68E+0	2.767E-8	2.398E-8	4.634E-8	4.516E-8	4.601E-8	4.220E-9	3.995E-8
7.41E+0	2.264E-8	1.343E-8	7.156E-8	7.212E-8	2.711E-8	5.778E-9	4.072E-8
1.49E+1	1.761E-8	8.153E-9	4.118E-8	6.197E-8	1.041E-8	6.662E-9	4.111E-8

Table 5

The Average Error (%) on the Fit to the Detector Data for each Spectrum and Matrix Using Only the MAXIET Algorithm to Determine the Spectrum

SPECTRUM NUMBER	MATRIX SAN4	M60	M65	LOGNM	BARC	UTA4
1	0.60	2.10	1.03	0.68	7.19	0.65
2	0.63	5.28	3.03	0.50	6.23	0.73
3	1.35	1.55	2.04	2.55	5.45	1.04
4	1.97	1.85	3.61	1.58	11.93	0.33
5	0.57	1.74	2.53	0.78	7.61	0.46
6	1.28	2.65	3.85	1.01	7.43	1.02
7	0.52	2.63	2.79	0.70	5.75	0.60
8	1.31	2.82	3.64	1.47	3.48	1.09
9	0.96	3.27	3.64	0.49	6.04	1.86
10	2.13	3.11	4.21	1.35	4.84	1.81
11	1.30	4.27	5.50	5.44	8.10	0.72
12	1.23	3.80	4.92	1.39	4.08	1.46
13	0.90	3.83	7.92	1.82	8.25	0.98
14	1.18	3.01	4.05	1.57	4.35	0.99
15	1.03	3.91	7.33	1.56	6.65	0.95
16	1.47	3.09	5.95	2.29	5.33	0.97
17	2.24	5.55	7.43	0.89	3.38	2.00
18	0.71	3.61	5.75	2.01	2.99	0.55
19	1.18	4.18	5.45	0.93	1.20	1.07
20	1.09	4.77	6.29	0.57	2.50	1.03
AVERAGE	1.18	3.35	4.55	1.48	5.64	1.02
S.D.	0.49	1.13	1.88	1.11	2.46	0.46

Table 6

The Average Error (%) on the Fit to the Detector Data for Each Spectrum and Matrix Using MAXIET and YOGI to Determine the Spectrum

SPECTRUM NUMBER	MATRIX SAN4	M60	M65	LOGNM	BARC	UTA4
1	0.49	1.63	0.65	0.63	6.14	0.62
2	0.62	0.84	1.33	0.39	5.77	0.60
3	0.47	1.36	1.21	0.57	4.69	0.49
4	0.65	1.68	2.96	1.17	9.15	0.33
5	0.42	1.24	1.78	0.47	6.37	0.32
6	0.51	1.41	2.71	0.37	6.46	0.65
7	0.31	1.43	1.71	0.30	4.31	0.26
8	0.83	2.25	2.00	1.09	1.58	0.96
9	0.40	1.66	2.29	0.26	4.63	0.55
10	1.23	2.00	2.62	0.20	3.08	1.02
11	0.36	2.16	3.75	1.10	6.61	0.42
12	0.64	2.86	2.59	0.74	1.74	0.63
13	0.50	3.35	4.46	1.45	6.45	0.69
14	1.09	2.07	1.97	1.43	1.18	0.84
15	0.64	3.24	3.61	1.34	3.81	0.68
16	1.24	2.66	2.60	2.14	2.90	0.89
17	1.25	4.60	3.39	0.72	0.88	1.38
18	0.53	3.28	3.00	1.74	1.40	0.44
19	0.78	3.56	2.83	0.88	0.44	0.64
20	0.51	3.83	2.91	0.47	0.56	0.65
AVERAGE	0.67	2.36	2.52	0.87	3.91	0.65
S.D.	0.30	1.02	0.93	0.54	2.53	0.27

Table 7a

The Percent Deviation of the Calculated Detector Data from the Experimental Detector Data for the M60 Response Matrix

SPECTRUM NUMBER	DETECTORS 2"	3"	5"	8"	10"	12"
1	0.70	-1.97	2.58	-2.13	0.65	0.25
2	-0.00	-0.21	0.62	-1.38	1.34	-0.35
3	-0.19	-0.17	0.52	-1.81	2.59	-0.88
4	0.65	-1.26	1.30	-2.37	2.62	-0.86
5	-0.02	-0.01	0.27	-1.65	2.37	-0.92
6	-0.10	0.15	0.17	-1.83	2.73	-1.06
7	-0.14	0.00	0.53	-2.07	2.62	-0.89
8	0.28	-0.42	1.28	-3.56	3.79	-1.21
9	0.03	-0.06	0.66	-2.50	2.97	-1.02
10	-0.27	0.68	-0.09	-2.59	3.84	-1.45
11	-0.03	0.03	0.68	-3.15	3.97	-1.37
12	0.29	0.04	1.37	-4.56	4.86	-1.68
13	-0.46	1.09	-0.22	-3.58	6.60	-3.11
14	-0.02	0.32	0.45	-3.21	3.72	-1.13
15	-0.08	0.95	-0.52	-3.78	6.38	-2.65
16	0.05	0.85	-0.72	-2.70	5.24	-2.52
17	0.37	2.33	-2.29	-3.81	8.84	-4.82
18	0.14	0.79	-0.67	-3.62	6.51	-2.84
19	0.45	1.05	-1.03	-3.99	6.95	-3.06
20	0.35	1.53	-1.63	-3.54	7.50	-3.78
AVERAGE	0.10	0.28	0.16	-2.89	4.30	-1.77
S.D.	0.30	0.95	1.12	0.91	2.21	1.27

Table 7b.

The Percent Deviation of the Calculated Detector Data from the Experimental Detector Data for the M65 Response Matrix

SPECTRUM NUMBER	DETECTORS 2"	3"	5"	8"	10"	12"
1	0.09	-0.08	-0.27	-0.63	1.36	-0.46
2	-0.48	0.97	-1.02	-1.21	2.53	-0.75
3	-0.53	0.85	-0.66	-1.36	2.28	-0.53
4	0.27	0.53	-1.56	-3.64	5.92	-1.25
5	-0.41	1.02	-0.41	-2.68	3.18	-0.61
6	-1.07	2.35	-1.73	-3.16	4.84	-1.01
7	-0.77	1.27	-0.22	-2.61	2.87	-0.45
8	-0.14	0.09	1.13	-3.49	3.17	-0.65
9	-0.86	1.73	-0.29	-3.48	3.86	-0.80
10	-1.63	2.96	-1.49	-2.73	4.31	-1.23
11	-1.14	3.00	-1.09	-5.35	6.49	-1.49
12	-0.68	1.56	0.85	-4.77	3.69	-0.45
13	-1.62	4.91	-1.13	-6.49	6.72	-1.81
14	-0.55	1.83	0.68	-3.65	2.34	-0.54
15	-1.17	3.21	-0.67	-5.19	5.99	-1.78
16	-0.69	1.78	0.16	-4.26	4.21	-0.98
17	-1.39	3.42	-1.40	-4.36	5.66	-1.60
18	-1.06	2.24	0.16	-5.02	4.68	-0.75
19	-1.24	2.69	-0.35	-4.39	4.39	-0.87
20	-0.80	2.88	-0.38	-4.20	4.56	-1.80
AVERAGE	-0.79	1.96	-0.48	-3.63	4.15	-0.99
S.D.	0.52	1.25	0.81	1.48	1.50	0.48

Table 7c

The Percent Deviation of the Calculated Detector Data from the Experimental Data Data for the SAN4 Response Matrix

SPECTRUM NUMBER	DETECTORS 2"	3"	5"	8"	10"	12"
1	0.22	-0.63	0.84	-0.53	-0.05	0.16
2	-0.09	0.37	-0.63	0.39	0.88	-0.90
3	-0.15	0.28	-0.32	-0.05	0.86	-0.62
4	-0.53	1.00	0.22	-0.95	-0.25	0.53
5	-0.01	0.14	-0.39	0.73	-0.59	0.13
6	-0.18	0.46	-0.80	0.80	-0.03	-0.24
7	-0.16	0.30	-0.40	0.52	-0.22	-0.03
8	0.22	-0.49	0.75	-1.30	1.23	-0.39
9	-0.18	0.39	-0.61	0.53	0.16	-0.29
10	-0.71	1.53	-1.86	1.08	0.91	-0.91
11	-0.19	0.48	-0.53	0.44	-0.03	-0.17
12	-0.20	0.42	-0.41	-0.35	1.22	-0.67
13	-0.15	0.52	-0.84	0.66	0.09	-0.27
14	-0.04	0.40	-0.80	1.77	-1.75	0.46
15	-0.17	0.55	-0.91	1.08	-0.38	-0.15
16	-0.07	0.20	-0.25	1.39	-2.40	1.17
17	-0.60	1.67	-1.78	0.07	1.55	-0.86
18	-0.08	0.24	-0.37	0.76	-0.90	0.36
19	-0.36	0.99	-1.25	0.76	0.36	-0.48
20	-0.15	0.60	-0.85	0.62	-0.01	-0.21
AVERAGE	-0.17	0.47	-0.56	0.42	0.03	-0.17
S.D.	0.23	0.55	0.67	0.76	0.98	0.53

Table 7d.

The Percent Deviation of the Calculated Detector Data from the Experimental Detector Data for the LOGNM Response Matrix.

SPECTRUM NUMBER	DETECTORS 2"	3"	5"	8"	10"	12"
1	0.04	-0.43	0.92	-1.03	-0.05	0.56
2	-0.07	0.17	-0.21	-0.15	0.75	-0.49
3	0.15	-0.37	0.69	-1.03	0.49	0.08
4	0.20	-0.94	1.97	-1.44	-0.68	0.93
5	0.05	-0.27	0.43	0.02	-0.83	0.61
6	0.09	-0.27	0.48	-0.24	-0.49	0.45
7	0.10	-0.22	0.33	-0.13	-0.46	0.39
8	0.34	-0.63	1.13	-1.83	1.36	-0.34
9	0.14	-0.25	0.37	-0.30	-0.19	0.24
10	-0.11	0.27	-0.33	0.14	0.14	-0.10
11	0.31	-0.79	1.67	-1.26	-0.99	1.09
12	0.17	-0.43	0.92	-1.33	0.70	-0.01
13	0.15	-0.58	1.90	-2.00	-1.20	1.80
14	0.36	-0.86	1.25	0.30	-2.65	1.66
15	0.35	-1.03	1.92	-1.05	-1.61	1.47
16	0.32	-0.91	1.99	-0.78	-3.56	3.07
17	-0.11	0.39	-0.52	-0.26	1.38	-0.87
18	0.06	-0.46	1.54	-1.74	-2.14	2.83
19	0.10	-0.50	1.06	-1.03	-0.83	1.23
20	0.09	-0.35	0.64	-0.38	-0.56	0.57
AVERAGE	0.14	-0.42	0.91	-0.78	-0.57	0.76
S.D.	0.15	0.39	0.78	0.69	1.27	1.03

Table 7e.

The Percent Deviation of the Calculated Detector Data from the Experimental Detector Data for the BARC Response Matrix.

SPECTRUM NUMBER	DETECTORS 2"	3"	5"	8"	10"	12"
1	1.35	-0.10	-3.81	10.45	- 9.63	2.87
2	-0.10	2.60	-4.91	8.65	- 8.95	3.67
3	-1.00	3.55	-3.50	5.74	- 7.74	3.61
4	8.00	-9.32	-5.89	13.43	- 9.92	6.19
5	0.57	2.71	-4.17	7.79	-11.24	5.59
6	-0.45	3.90	-4.88	8.09	-10.79	5.41
7	-1.37	3.10	-0.62	3.16	- 8.28	4.59
8	-0.74	1.76	-0.53	0.56	- 2.76	1.79
9	-1.31	3.97	-1.97	2.82	- 8.32	5.47
10	-1.62	3.79	-1.57	1.36	- 4.98	3.31
11	-0.08	4.49	-6.22	8.02	-10.40	5.52
12	-1.13	2.46	-0.57	0.15	- 2.66	1.83
13	-0.53	7.05	-4.94	3.74	-10.78	6.74
14	-0.93	1.64	-0.19	-0.05	- 1.75	1.31
15	-1.20	5.93	-3.10	0.62	- 5.31	3.49
16	-1.68	4.16	-0.15	0.17	- 4.84	2.60
17	-0.19	1.13	-1.75	0.38	0.41	0.04
18	-1.04	2.05	-0.14	-0.40	- 1.98	1.56
19	-0.41	0.79	-0.27	-0.04	- 0.40	0.32
20	0.31	-0.11	-0.99	0.22	0.85	-0.26
AVERAGE	-0.18	2.28	-2.51	3.74	- 5.97	3.28
S.D.	2.07	3.29	2.12	4.25	4.11	2.12

Table 7f.

The Percent Deviation of the Calculated Detector Data from the Experimental Detector Data for the UTA4 Response Matrix.

SPECTRUM NUMBER	DETECTORS 2"	3"	5"	8"	10"	12"
1	0.11	-0.57	1.06	-0.81	-0.14	0.36
2	-0.11	0.40	-0.57	0.22	0.93	-0.85
3	-0.13	0.21	-0.19	-0.28	0.97	-0.57
4	0.05	-0.27	0.55	-0.49	0.10	0.06
5	-0.06	0.16	-0.39	0.58	-0.31	0.03
6	-0.29	0.66	-1.05	0.75	0.41	-0.47
7	-0.18	0.30	-0.37	0.37	-0.01	-0.12
8	0.29	-0.55	0.85	-1.51	1.40	-0.45
9	-0.35	0.65	-0.76	0.49	0.47	-0.47
10	-0.70	1.49	-1.55	0.54	0.76	-0.51
11	-0.14	0.44	-0.61	0.22	0.50	-0.39
12	-0.15	0.30	-0.12	-0.69	1.21	-0.55
13	-0.30	0.79	-0.93	0.31	0.85	-0.71
14	-0.20	0.54	-0.79	1.29	-1.22	0.39
15	-0.29	0.83	-1.14	0.68	0.33	-0.39
16	0.04	0.05	-0.37	1.40	-1.55	0.45
17	-0.44	1.71	-1.78	-0.10	1.90	-1.24
18	-0.21	0.52	-0.66	0.61	-0.13	-0.13
19	-0.28	0.93	-0.94	0.22	0.59	-0.51
20	-0.28	0.94	-1.02	0.35	0.44	-0.43
AVERAGE	-0.18	0.48	-0.54	0.21	0.38	-0.33
S.D.	0.21	0.58	0.72	0.70	0.82	0.43

Table 8.

The Measured Counts, Calculated Counts, and Percent Difference Between the Calculated Counts and Measured Counts for the Cf-252 Spectrum.

DETECTOR DIAMETER (IN)	MEASURED COUNTS	CALCULATED COUNTS AND % DIFFERENCE ( )					
		SAN4	M60	M65	LOGNM	BARC	UTA4
2	1.37	1.47 (7.53)	1.11 (-18.89)	1.05 (-23.51)	0.94 (-31.25)	1.70 (23.71)	1.17 (-14.50)
3	7.20	7.60 (5.56)	6.13 (-14.82)	6.18 (-14.06)	6.51 (-9.59)	6.87 (-4.59)	6.85 (-4.92)
5	24.20	24.24 (0.14)	23.70 (-2.07)	24.23 (0.10)	25.19 (-4.10)	21.65 (-10.53)	24.64 (1.80)
8	29.13	27.92 (-4.16)	30.94 (6.23)	32.03 (9.95)	32.63 (12.02)	30.91 (6.12)	30.50 (4.70)
10	22.52	21.55 (-4.30)	26.94 (19.62)	28.21 (25.27)	27.24 (20.96)	19.38 (-13.95)	24.21 (7.52)
12	15.58	15.04 (-3.46)	19.61 (25.84)	19.95 (21.61)	20.52 (31.70)	16.91 (8.52)	17.10 (9.77)
AVERAGE DIFFERENCE (%)		3.52	14.58	15.74	18.27	11.24	7.20

Table 9.

The Measured Counts, Calculated Counts, and Percent Difference Between Calculated Counts and Measured Counts for the Room-Return Spectrum of Cf-252.

		CALCULATED COUNTS AND % DIFFERENCE ( )					
DETECTOR DIAMETER (IN)	MEASURED COUNTS	SAN4	M60	M65	LOGNM	BARC	UTA4
2	15.91	15.49 (-2.62)	10.65 (-33.06)	13.92 (-12.49)	13.31 (-16.36)	15.95 (0.27)	14.55 (-8.55)
3	24.21	24.61 (1.64)	20.41 (-15.69)	22.05 (-8.91)	22.01 (-9.08)	21.62 (-10.72)	23.40 (-3.33)
5	28.80	28.88 (0.29)	28.90 (0.33)	27.34 (-5.08)	27.73 (-3.70)	25.84 (-10.29)	28.74 (-0.22)
8	16.64	16.59 (-0.30)	19.36 (16.32)	16.93 (1.72)	17.15 (3.07)	18.36 (10.35)	17.13 (2.93)
10	9.30	9.43 (1.35)	12.91 (38.78)	11.67 (25.47)	10.57 (13.63)	9.01 (-3.12)	9.89 (6.33)
12	5.15	5.14 (-0.24)	6.93 (34.55)	5.56 (8.00)	6.31 (22.58)	6.21 (20.54)	5.38 (4.40)
AVERAGE DIFFERENCE	(%)	1.45	21.85	9.07	10.33	8.80	3.23

Table 10a.

The Average Neutron Fluence Obtained Using All the Matrices and the Ratio of the Fluence Obtained with each Matrix to the Average Fluence

SPECTRUM NUMBER	AVERAGE	RATIO (EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	M60	M65	LOGAN	EARC	UTA4
1	1.416	1.013	0.983	1.008	0.977	1.012	1.007
2	1.436	1.005	1.062	0.994	0.948	1.014	0.977
3	1.526	1.013	1.120	0.952	0.949	0.994	0.971
4	1.274	1.000	1.000	1.000	1.000	1.000	1.000
5	1.376	1.008	1.070	0.990	0.965	0.989	0.978
6	1.371	1.008	1.078	0.972	0.994	0.972	0.976
7	1.654	1.094	1.202	0.915	0.951	0.871	0.966
8	1.696	1.107	1.228	0.960	0.919	0.880	0.963
9	1.524	1.044	1.197	0.947	0.967	0.915	0.931
10	1.681	1.080	1.235	0.962	0.967	0.861	0.954
11	1.433	1.068	1.094	0.973	0.969	0.964	0.971
12	1.659	1.027	1.248	0.932	0.956	0.867	0.950
13	1.573	1.012	1.123	0.967	1.017	0.925	0.956
14	1.691	1.050	1.289	0.900	0.969	0.874	0.919
15	1.628	1.004	1.167	0.947	1.021	0.930	0.930
16	1.667	1.022	1.201	0.937	0.972	0.920	0.947
17	1.736	1.049	1.263	0.964	0.955	0.866	0.941
18	1.709	1.061	1.262	0.900	0.968	0.891	0.917
19	1.831	1.056	1.310	0.865	0.992	0.840	0.937
20	1.736	1.039	1.285	0.881	0.980	0.893	0.921

Table 10b.

The Average Average-Energy Obtained Using All the Matrices and the Ratio of the Average-Energy Obtained with Each Matrix to the Average Average-Energy

SPECTRUM NUMBER	AVERAGE	RATIO(EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	MOO	RE5	LOGAN	EARC	UTA4
1	4.263	1.129	0.891	1.038	0.906	0.965	1.071
2	3.355	1.081	0.939	1.114	0.849	0.999	1.018
3	2.610	1.045	0.900	1.028	0.836	1.150	1.042
4	1.747	1.234	0.897	1.026	0.823	0.912	1.106
5	1.340	1.250	0.865	1.080	0.815	0.869	1.121
6	1.331	1.202	0.903	1.007	0.867	0.897	1.123
7	1.259	1.040	0.954	1.095	0.822	1.024	1.065
8	1.008	1.084	1.147	0.929	0.752	1.014	1.073
9	0.992	1.177	0.991	1.096	0.850	0.815	1.071
10	0.702	1.100	1.131	1.080	0.872	0.672	1.145
11	0.678	1.231	0.945	0.974	0.812	0.901	1.137
12	0.376	1.148	0.985	1.319	0.734	0.644	1.169
13	0.244	1.500	0.839	0.944	0.837	0.650	1.231
14	0.176	1.415	0.843	1.300	0.756	0.476	1.209
15	0.178	1.597	0.877	0.931	0.809	0.503	1.283
16	0.136	1.701	0.796	0.998	0.775	0.340	1.390
17	0.129	1.551	0.946	1.265	0.655	0.288	1.295
18	0.120	1.706	0.929	1.051	0.691	0.262	1.361
19	0.102	1.585	0.962	1.465	0.506	0.146	1.336
20	0.100	1.718	0.900	1.228	0.589	0.167	1.399

Table 10c.

The Average Dose Obtained Using All the Matrices,
and the Ratio of Dose Obtained with each
Matrix to the Average Dose

SPECTRUM NUMBER	AVERAGE	RATIO (EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	R60	RC5	LOGNM	EARC	UTA4
1	6.441	1.066	0.937	1.001	0.944	0.998	1.034
2	5.405	1.067	0.980	1.011	0.903	1.040	0.999
3	4.391	1.084	0.948	0.952	0.893	1.122	1.001
4	4.235	1.114	0.930	0.951	0.924	1.048	1.032
5	3.506	1.137	0.965	0.969	0.915	0.975	1.040
6	3.544	1.126	0.972	0.945	0.930	0.990	1.034
7	2.653	1.135	1.004	0.930	0.896	1.024	1.011
8	2.458	1.157	1.095	0.910	0.860	0.969	1.009
9	2.810	1.150	1.009	0.947	0.915	0.950	1.029
10	2.212	1.173	1.078	0.931	0.906	0.875	1.035
11	2.030	1.159	0.983	0.963	0.933	0.962	1.040
12	1.796	1.195	1.097	0.944	0.893	0.829	1.042
13	1.777	1.266	1.028	0.879	0.945	0.792	1.068
14	1.442	1.253	1.139	0.900	0.898	0.766	1.042
15	1.544	1.298	1.060	0.887	0.943	0.742	1.071
16	1.410	1.305	1.114	0.884	0.914	0.703	1.080
17	1.311	1.293	1.127	0.850	0.904	0.727	1.058
18	1.326	1.319	1.133	0.878	0.894	0.707	1.066
19	1.252	1.289	1.160	0.884	0.898	0.722	1.047
20	1.236	1.291	1.151	0.866	0.894	0.722	1.057

Table 10d.

The Average Dose Equivalent Obtained Using All the Matrices and the Ratio of the Dose Equivalent Obtained with Each Matrix to the Average Dose Equivalent

SPECTRUM NUMBER	AVERAGE	RATIO(EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	ROU	BES	LOGAN	EARC	UTA4
1	5.061	1.053	0.962	0.970	0.954	1.056	1.005
2	4.253	1.060	0.964	0.960	0.939	1.037	0.999
3	3.415	1.086	0.960	0.943	0.926	1.074	1.009
4	4.021	1.063	0.932	0.917	0.955	1.103	1.010
5	3.141	1.135	0.951	0.916	0.960	1.004	1.034
6	3.249	1.126	0.949	0.912	0.962	1.021	1.030
7	2.240	1.143	0.949	0.910	0.949	1.016	1.033
8	1.673	1.212	1.014	0.874	0.911	0.939	1.050
9	2.307	1.166	0.949	0.904	0.963	0.969	1.050
10	1.609	1.232	0.971	0.891	0.937	0.898	1.069
11	2.437	1.205	0.941	0.851	0.962	0.991	1.051
12	1.226	1.344	0.956	0.837	0.926	0.815	1.121
13	1.424	1.457	0.962	0.756	0.935	0.752	1.137
14	0.834	1.523	0.924	0.794	0.896	0.665	1.198
15	1.075	1.556	0.954	0.756	0.914	0.630	1.190
16	0.871	1.617	1.000	0.700	0.881	0.504	1.237
17	0.677	1.627	0.982	0.766	0.890	0.536	1.199
18	0.729	1.671	0.997	0.755	0.829	0.479	1.270
19	0.543	1.738	0.969	0.787	0.775	0.472	1.259
20	0.578	1.703	0.983	0.798	0.802	0.451	1.262

Table 10e.

The Average Quality Factor Obtained Using All the Matrices and the Ratio of the Qaulity Factor Obtained with Each Matrix to the Average Quality Factor

SPECTRUM NUMBER	AVERAGE	RATIO (EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	M60	R65	LOGNM	BARC	UIA4
1	7.866	0.969	1.026	0.968	1.010	1.057	0.971
2	7.876	0.993	1.063	0.965	1.040	0.996	0.999
3	7.791	1.001	1.011	0.989	1.038	0.955	1.006
4	9.498	0.972	1.002	0.963	1.033	1.052	0.978
5	8.965	0.998	0.966	0.944	1.049	1.029	0.994
6	9.166	0.998	0.975	0.964	1.034	1.032	0.996
7	7.854	1.006	0.945	0.979	1.059	0.993	1.018
8	6.811	1.048	0.926	0.960	1.058	0.968	1.040
9	8.426	1.013	0.940	0.954	1.052	1.020	1.020
10	7.276	1.050	0.961	0.956	1.032	1.026	1.033
11	9.271	1.045	0.959	0.944	1.032	1.010	1.010
12	6.663	1.129	0.875	0.890	1.041	0.966	1.060
13	7.924	1.145	0.946	0.870	1.001	0.960	1.077
14	5.712	1.232	0.822	0.893	1.012	0.877	1.105
15	6.022	1.223	0.918	0.863	0.963	0.867	1.134
16	5.396	1.277	0.926	0.886	0.993	0.759	1.160
17	5.032	1.292	0.895	0.863	1.010	0.757	1.164
18	5.316	1.311	0.910	0.830	0.959	0.701	1.223
19	4.165	1.397	0.865	0.922	0.894	0.677	1.244
20	4.514	1.367	0.864	0.933	0.930	0.648	1.238

Table 10f.

The Average Navy TLD Badge Response Obtained Using All the Matrices and the Ratio of the Response Obtained Using Each Matrix to the Average Response

SPECTRUM NUMBER	AVERAGE	RATIO (EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	ROO	ACD	LOGAN	EARC	UTA4
1	0.820	0.883	1.079	1.056	1.076	0.914	0.983
2	1.330	0.894	1.193	0.975	1.027	0.958	0.953
3	2.479	0.887	1.310	0.966	1.021	0.885	0.932
4	1.118	0.846	1.111	1.123	1.099	0.845	0.974
5	2.203	0.816	1.211	1.060	1.028	0.972	0.913
6	2.079	0.824	1.222	1.045	1.059	0.946	0.904
7	5.356	0.947	1.358	0.953	0.993	0.831	0.912
8	7.771	0.893	1.275	0.961	1.006	0.946	0.897
9	4.296	0.856	1.360	0.993	1.002	0.963	0.826
10	6.016	0.846	1.329	0.965	1.015	0.992	0.851
11	3.162	0.772	1.225	1.131	1.013	0.965	0.894
12	10.849	0.705	1.334	1.034	1.010	1.114	0.803
13	7.465	0.802	1.160	1.229	1.016	1.196	0.778
14	16.290	0.618	1.361	1.030	1.002	1.289	0.700
15	11.636	0.540	1.185	1.157	1.014	1.410	0.695
16	17.102	0.512	1.121	1.065	0.937	1.086	0.600
17	23.813	0.537	1.224	1.059	0.953	1.330	0.676
18	22.413	0.519	1.168	1.027	0.939	1.677	0.610
19	34.594	0.503	1.228	0.950	1.097	1.596	0.632
20	30.565	0.481	1.176	0.960	1.042	1.740	0.602

Table 10g.

The Average "Hankins" TLD Badge Response Obtained Using All the Matrices and the Ratio of the Response Obtained Using Each Matrix to the Average Response

SPECTRUM NUMBER	AVERAGE	RATIO (EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	M00	M65	LOGNA	LARC	UIA4
1	0.761	0.809	1.110	1.067	1.137	0.891	0.966
2	1.898	0.800	1.361	1.033	0.964	0.871	0.910
3	3.143	1.146	1.151	0.789	0.840	1.196	0.878
4	1.166	0.785	1.170	1.268	1.105	0.760	0.973
5	3.148	0.755	1.384	1.110	0.982	0.859	0.910
6	2.994	0.833	1.520	1.115	0.771	0.870	0.889
7	6.574	0.979	1.187	0.669	0.680	1.729	0.757
8	11.107	0.727	1.118	1.125	0.890	1.391	0.749
9	6.509	0.904	1.100	0.957	0.717	1.261	1.061
10	11.923	0.829	1.107	1.035	0.685	1.506	0.837
11	4.477	0.737	1.297	1.287	0.923	0.867	0.867
12	18.297	0.758	1.274	1.158	0.755	1.302	0.754
13	11.690	0.609	1.330	1.370	0.837	1.079	0.773
14	34.009	0.548	1.406	1.207	0.670	1.462	0.706
15	18.251	0.567	1.197	1.333	0.771	1.367	0.805
16	27.028	0.531	1.328	1.058	0.827	1.043	0.611
17	33.664	0.629	0.592	1.304	0.824	1.835	0.796
18	36.356	0.496	0.712	1.267	0.810	2.015	0.680
19	50.351	0.597	0.341	1.234	0.677	2.300	0.650
20	47.322	0.561	0.676	1.252	0.759	2.031	0.722

Table 10h.

The Average CR-39 Badge Response Obtained Using All the Matrices and the Ratio of the Response Obtained Using Each Matrix to the Average Response

SPECTRUM NUMBER	AVERAGE	RATIO(EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	R60	R65	LOGNA	EARC	U1A4
1	1.199	1.044	0.949	1.023	1.016	0.941	1.027
2	1.177	1.034	0.924	0.967	0.990	1.002	1.023
3	1.155	1.017	0.905	1.044	1.001	1.017	1.016
4	0.906	1.095	0.963	1.130	0.893	0.861	1.058
5	0.913	1.038	0.958	1.147	0.863	0.964	1.030
6	0.872	1.071	0.906	1.086	0.872	0.950	1.035
7	0.902	1.045	0.940	1.122	0.867	0.962	1.044
8	0.971	0.9[illegible]2	0.901	1.206	0.901	1.020	1.000
9	0.841	1.024	0.967	1.127	0.833	0.995	1.033
10	0.803	0.960	0.969	1.170	0.899	1.000	1.002
11	0.651	1.027	1.038	1.139	0.862	0.908	1.026
12	0.670	0.950	0.998	1.372	0.734	0.928	1.017
13	0.483	1.074	0.858	0.937	0.999	1.061	1.072
14	0.490	1.029	0.919	1.384	0.833	0.839	0.996
15	0.446	1.120	0.640	0.943	0.945	1.035	1.118
16	0.421	1.142	0.923	0.949	0.923	0.949	1.113
17	0.422	1.080	0.741	1.530	0.836	0.770	1.042
18	0.395	1.166	0.885	1.164	0.888	0.708	1.169
19	0.322	1.386	0.714	1.882	0.509	0.298	1.208
20	0.360	1.262	0.809	1.576	0.790	0.356	1.207

Table 10i.

The Average NTA Film Badge Response Obtained Using All the Matrices and the Ratio of the Response Obtained Using Each Matrix to the Average Response

SPECTRUM NUMBER	AVERAGE	RATIO(EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	R00	M65	LOGNM	BARC	UIA4
1	1.299	1.055	0.942	1.034	0.995	0.936	1.037
2	1.255	1.034	0.947	0.999	0.958	1.046	1.017
3	1.201	1.022	0.910	1.027	0.958	1.071	1.011
4	0.895	1.106	0.964	1.111	0.891	0.863	1.065
5	0.895	1.062	0.934	1.106	0.871	0.961	1.046
6	0.851	1.066	0.977	1.055	0.863	0.949	1.049
7	0.903	1.036	0.935	1.067	0.833	1.053	1.034
8	0.966	0.958	0.944	1.154	0.833	1.106	0.984
9	0.819	1.043	0.979	1.101	0.833	1.014	1.030
10	0.764	0.984	0.967	1.165	0.846	1.021	1.016
11	0.530	1.087	1.006	1.079	0.811	0.934	1.004
12	0.623	0.961	0.983	1.466	0.661	0.978	0.991
13	0.332	1.236	0.962	1.266	0.614	0.743	1.173
14	0.436	1.057	0.960	1.495	0.575	0.865	1.024
15	0.314	1.247	1.056	1.349	0.439	0.697	1.212
16	0.266	1.413	1.037	1.510	0.331	0.391	1.319
17	0.324	1.227	1.030	1.946	0.256	0.234	1.307
18	0.267	1.392	1.041	1.733	0.266	0.243	1.303
19	0.260	1.457	0.846	2.291	0.042	0.000	1.365
20	0.288	1.342	1.069	1.939	0.232	0.003	1.394

Table 10j.

The Average AN/PDR-70 Remmeter Response Obtained Using All the Matrices and the Ratio of the Response Obtained Using Each Matrix to the Average Response

SPECTRUM NUMBER	AVERAGE	RATIO (EACH RESPONSE MATRIX/AVERAGE)					
		SAN4	MOD	MC5	LOGRM	BARC	UTA4
1	0.799	0.928	1.036	0.933	1.027	1.142	0.934
2	0.830	0.983	0.993	0.919	1.080	1.024	1.000
3	0.872	0.987	1.043	0.999	1.070	0.897	1.004
4	1.037	0.971	1.001	0.996	1.028	1.021	0.983
5	1.038	0.975	0.987	0.962	1.034	1.057	0.984
6	1.042	0.988	0.977	0.992	1.013	1.039	0.991
7	1.011	0.999	0.991	0.998	1.040	0.955	1.008
8	0.926	1.015	0.921	1.036	1.080	0.927	1.021
9	1.052	0.982	0.981	0.983	1.019	1.046	0.990
10	1.032	0.993	0.943	0.987	1.019	1.067	0.991
11	1.057	1.011	0.991	1.030	0.985	0.965	0.998
12	1.061	0.997	0.965	0.984	0.999	1.034	1.001
13	1.069	0.975	1.019	1.066	0.973	0.977	0.989
14	1.116	0.973	0.993	1.014	0.978	1.063	0.979
15	1.122	0.958	1.027	1.053	0.972	1.016	0.973
16	1.141	0.940	0.987	1.045	0.966	1.096	0.958
17	1.184	0.946	0.993	1.057	0.944	1.088	0.971
18	1.161	0.937	0.973	1.052	0.966	1.128	0.944
19	1.178	0.933	0.963	1.008	0.996	1.147	0.952
20	1.215	0.924	0.974	1.021	0.956	1.184	0.942

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